THE SQUARE AND Cube Root COMPLEATED, AND MADE EASIE.

BEING

A Secret never yet manifeſted; but the contrary acknowledged by ſundry Artiſts.

By *Peter Halliman*, of *Stockton*, in the County of *Durham*.

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LICENSED,

Nov. 7.
1685.

ROB. MIDGLEY.

TO HIS

Moſt Excellent Majeſty,

JAMES II.

By the Grace of God, of *Great Britain*, *France*, and *Ireland*, King, *&c.*

SIR,

THE Fame of Your Knowledge in all Arts is ſpread over Your Kingdoms; and that You delight to encourage Art and Ingenuity, is the Univerſal Conſent of all Your Subjects; ſo

that thus Encouraged, I ventured to crowd to Your Majeſties Feet, to preſent my poor Services, with this my Labour, to Your Royal Favour, imploring Your Patronage of this little Treatiſe, whoſe Contents, tho by ſeveral the moſt Curious Enquirers long ſought for, yet now but found out, and demonſtratively ſhewn; ſetting forth an eaſie and exact way to find either the Square or Cube Root, which never was attained to, or Publiſhed by any before; being uſeful for Ship-

wrights,

wrights, Sea-men, Gunners, Souldiers, Surveyors, for Gauging, and for Merchants, and both uſeful and delightful for Gentlemen. But how my Unworthineſs may attone for this Preſumption, I cannot find but in Your Royal Gracious diſpoſition. Thus in all humility of Allegiance, I offer my ſelf, and this my Labour, to Your Majeſties Acceptance, who am

Your Majeſty's

Moſt Humble, and

Faithful Subject,

Peter Halliman.

THE PREFACE TO THE READER.

READER,

IN this Book, you may readily find the Square Root of any number, to 1488400, *and the Cubick Root of any number to* 9261000; *And alſo the true and exact value of the Remainer, and that not by Ternaries, to gueſs almoſt, or very nigh, as by that tedious way of adding of Ciphers, or by Logarithmes, but exactly, and with ſo much eaſe,*

eaſe, that one of a weak capacity may do it; and thereby you may readily find the exact ſides of Triangles, although the given ſides contain both whole numbers and broken, as Leagues, and parts of Leagues; or Miles, and parts of Miles; or Inches, and parts of Inches: Alſo you may readily find the Cubick number of any Cubick Root, although the Root contain both whole numbers and broken. So that now the Rule is Compleated, and as formerly the Rule was laid aſide, or very little uſed, being ſo very tedious, and difficult to work any one queſtion, and when all their labour was ſpent, they did but gueſs at the Remainer: Now the Rule is made eaſier, than any Rule in the Arithmetick, ſo that twenty Queſtions may be anſwered in a little time exactly, with delight. I have carefully look'd, and examin'd the Queſtions and Tables in this Treatiſe, and I cannot find one wrong figure. Now Loving Neighbours *and kind* Countrymen *if this my labour be accepted, and find entertainment amongſt you, I ſhall, God willing, preſent you with another piece of my labour, that I hope will be uſeful. In this Book the knot is opened, the ſecret is found out, the*

Gate

Gate is ſet open, the way is made good, Plain, Streight and Eaſy, walk therein, and God give a bleſſing to honeſt lawful labour. Reader, *the two excellent Rules of the Square and Cube Root being of ſo great uſe in the chiefeſt and greateſt buſineſs, both by Sea and Land; being ſo uſeful for building of Ships, and for Navigation, and in the Art of Gunnery; and alſo ſo uſeful at Land, in Martial Diſcipline, inſomuch that Mr.* John Roberts, *in his excellent Book of the Art of Gunnery, called* The Compleat Canonier, *declares, how neceſſary it is for any, intending to be a compleat martial man, to have good judgment in thoſe two Rules, and how far they are from being Souldiers that are ignorant thereof; although he had not found out that ſecret, the value of the Remainer of the Root; for he tells us how to gueſs within leſs than ordinary is known. Nevertheleſs, for all thoſe great concerns, and the great uſe thoſe two Rules are of, yet they have been laid aſide, and very little uſed, becauſe they were both tedious, and difficult to work, and alſo no true value could be found of the Remainer; for which reaſon thoſe two Rules have alſo*

been

been left out of the Arithmetick; for I find it in other Writings, that none as yet could ever attain to the value of the Remainer of the Root.

And ſome excellent Arithmeticians at London *told me, That no man in the City, nor in the Nation, nor in the World, could ever find out the exact value of the Remainer of the Root; and I, for ſaying that I had found out the true value of the Remainer, and alſo how to prove it exactly; as alſo an eaſie and ready way to find the Root of any number, which makes the Rules both uſeful and delightful; yet for ſaying ſo, I have been jeered, laught at, ſcorned, and derided by ſeveral good Arithmeticians, who told me, That there were others, ten times abler than I, that could not find it, and therefore it could not be expected from ſo mean and weak a hand as mine; indeed I acknowledge my meanneſs and weakneſs.*

They told truth

Yet God, who in his wiſdom diſpoſeth of his gifts ſeverally as he ſeeth good, was graciouſly pleaſed of his mercy to give me this, which in this Book I hope will ſufficiently appear, that what I ſaid I have made good, and

now

now I put it forth for the publick good of my Country-men of England; *hoping alſo my ſelf, with them, to be partaker in the benefit thereof. To God only be the praiſe of it.*

THE

THE TABLE.

THE

THE RULE OF THE SQUARE ROOT COMPLEATED:

AND ALSO The Rule of the Cube Root made Easie, &c.

HOw useful this present Work will be to Sea-men and Ship-wrights, and to others, will soon appear, by a little Practice herein; for I meeting with some questions to be wrought by the Square Root, and finding a great

want in the Rule, that no account could be given of the Remainer, which ſometimes was very conſiderable, I was thereby much hindered, and could not exactly finiſh the queſtions: and finding in the Sea-mans Kalendar, firſt ſet forth by Mr. *John Tap*, That none as yet could ever attain to the knowledge of the value of the Remainer, and therefore the Rule was much ſleighted; as alſo for the tedious way of working the Rule of the Square Root: And although the Sea-mans Kalendar hath been enlarged by others, yet it is ſtill acknowledged, that the value of the Remainer of the Root is not found out: Whereupon I undertook the ſearch of it; and God, to whom belongs all the praiſe of all our actions, was pleaſed to give me the finding of that Secret, both of the Square, and alſo of the Cube Root, with the true value of the Remainer: So that now he that hath a little knowledge of the Arithmetick, if he know but ſo far as Subſtraction, may, with eaſe, and readily find either the Square or Cube Root of any number to 1488400; and alſo the true value

of

of the Remainer: So that now any queſtion of the Square or Cube may be eaſily wrought, and readily anſwered, as will appear by what is done in this Book, and by which, much more may be done by any one that hath an ingenious Spirit: And although the curious and Expert Mariners have other ways, yet I hope a readier and an eaſier way will be kindly taken; and as for the meaner ſort who are willing and deſirous to learn the eaſieſt and readieſt way, I hope they will thank me for my labour; and alſo other Men that have occaſion for the Rules of the Square or Cube Root; for Building Ships, for Gunnery, for Military Diſcipline, for Meaſuring Timber, for Surveying, for Gageing, will all of them find the advantage of this Work, to whom I refer it with this Benediction; God increaſe your Knowledge, Health and Wealth, and long Life, and the knowledge of God, to whom be all praiſes. *Amen.*

The Rules of the Square and Cube Root Compleated.

I Shall here teach you a ready and an eaſie way to find the Root of any number, either of the Square or of the Cube; and therefore I ſhall paſs by the uſual way of extracting the Root, which was both tedious and difficult: Alſo I ſhall teach how to find the true value of the Remainer, and how to prove it exactly. For the finding of the Square Root of any number to 1488400, and for the finding of the Cube Root of any number to 9261000, I have here made a Table for the Square Root, and alſo a Table for the Cube Root, by which you may readily find any number propoſed, and the Root of it without further trouble. For example, let 256 be a given number, and you deſire to know the Square Root of it, look in the Table for the number 256 and in the next column right againſt it, towards the Right Hand, you have 16, the Root of it without further trouble, for 256 is a Square number, which cometh of 16 multiplied in it ſelf; again let 289 be

be a given number, and you would know the Root of it; look in the Table for the number 289, and right againſt it you have 17, the Root; therefore 289 is a Square number, produced of 17, multiplied in it ſelf: Here you ſee that 256, and alſo 289, are both of them Square numbers. Now all the numbers betwixt thoſe two numbers are not ſquare numbers, and there are 32 numbers betwixt them; for ſubſtract 256 from 289, and there remains 33, but leave out both the Square numbers, and there are but 32 numbers betwixt them. All which numbers are not Square numbers, for to any of them there will be a Remainer to the Root, the true value of which Remainer I ſhall ſhew, and alſo how to prove it; and here will that knot be enoded, that hath ſo long been tyed, and hath ſo much been ſought for by our beſt Arithmeticians.

Now for numbers not Square, let 262 be a given number; and you would know the Root of it, look in the Table for 262, and being that it is not in the Table, take the Square number that is

leſs than it, and next to it, which is 256, and ſubſtract it from your laſt given number, and there remains 6; therefore 16 is the Root, and 6 is the Remainer. Now obſerve that as 16 is the Root of the Square number 256; ſo alſo 16, with ſome Remainer is the Root of all thoſe 32 numbers, that are more than 256, and leſs than 289.

262	
256	
6	

Now for the true value of the Remainer in this laſt queſtion, 6 is the Remainer; now 6 is the Numerator, but we want a Denominator to it; look in the Table, as you did before, for the next Square number that is leſs than your given number, and you have towards your right hand the Root, and in the third Column the Denominator 33, for as 16 is the Root of 256, ſo 16 is the Root of all the numbers not Square till you come to 289; alſo 33 is the Denominator to all the Remainers of the Root of thoſe 32 numbers; the proofs whereof I ſhall ſhew you hereafter; and here I ſet down the queſtion thus:

Num-

Number	Root	Remainer
262	16	$\frac{6}{33}$

Which Remainer being abbrevied, is, $\frac{2}{11}$.

Again, let 286 be a given number, and you would know the Root of it, look in the Table for the neareſt Square number that is leſs than the given number, and you will find 256; which ſubſtract from the given number 286, and there remains 30. Here I find by this eaſie Subſtraction, that the Remainer to the Root of this number is 30, and the Table ſhews the Root to be 16. Alſo the Table ſhews the Denominator to be 33; and here I ſet down the Queſtion thus:

286
256
30

Number	Root	Remainer
286	16	$\frac{30}{33}$

Which Remainer being abbrevied, is, $\frac{10}{11}$.

Thus with much eaſe you may readily find the Root of any number, and the Remainer, with the Denominator to it; the proof of it I ſhall ſhew you hereafter.

Another Example or two will ſtill make it more plain; Let 10067 be a given number, and you would know the Root of it, look in the Table for the neareſt Square number, and leſs than your given number, and you will find it to be 10000, and toward the right hand you will find 100 for the Root of it, and 201 for the Denominator, then ſubſtract that Square number in the Table, 10000, from the given number, and there remains 67 for the Remainer to the Root; thus this eaſie Subſtraction gives you the Remainer, and the Table gives you the Root, and the Denominator to the Remainer, as here is ſet down:

10067	
10000	
67	

Number	Root	Remainer
10067	100	$\frac{67}{201}$

Which Remainer being abbrevied, makes $\frac{1}{3}$; therefore I anſwer to this queſtion, that the Root of 10067 is 100, and the Remainer is $\frac{1}{3}$, for it is the true value of the Remainer of the Root that belongs

longs to this number; thus you readily find the Root and the Remainer, and the Denominator to it.

Another Example: Let 10198 be a given number; and you would know the Root of it, look in the Table for the neareſt Square number that is leſs than your given number, and you will find 10000, and towards your right hand you will find 100 for the Root, and 201 for the Denominator; then Subſtract that Square number in the Table 10000, from the given number 10198, and there remains 198, which is the Remainer to the Root of that number, and the Table gives you the Root and the Denominator; as here ſet down.

10198	
10000	
198	

Number	Root	Remainer
10198	100	$\frac{198}{201}$

Which Fraction or Remainer being abbrevied makes $\frac{66}{67}$, that is near one whole: So that the Root of the given number is near 101, but, as I have ſaid, the juſt root is 100, $\frac{198}{201}$, or $\frac{66}{67}$.

Now

Now as I promiſed to prove the work, I will begin with the firſt number in the Table, that is 1. Where the number is 1, the root is 1, and no remainer; the next Square number is 4, the root is 2, and no remainer: now the numbers betwixt 1 and 4, are not Square numbers, being 2 and 3, therefore there is a remainer to the root of either of them. Now they have both one root, for as 1 is the root of 2, ſo alſo one is the root of 3, but they have not both one remainer, for to the root of 2 there remains 1, and to the root of 3 there remains 2. You ſee here that as the number increaſes, ſo the remainer increaſes, but the root is ſtill the ſame, till you come at the next Square number; now to find the exact value of the remainers, betwixt thoſe two Square numbers, is the thing ſet forth in writing, that none as yet could ever attain to. Now for the exact value of the remainer; there muſt be a denominator to the remainer, for what value can be put upon the numerator, if you know not the denominator belonging to it? I ſhall here give you a familiar Example or two, and then prove it by broken numbers. As

As I have ſaid, as the number increaſes, ſo the remainer increaſes, but one root ſerves to them all; ſo alſo one denominator ſerves to them all, and the denominator to thoſe two numbers, 2 and 3, the denominator to either of them is 3, therefore I ſet down the number thus:

Number	Root	Remainer
2	1	$\frac{1}{3}$

Number	Root	Remainer
3	1	$\frac{2}{3}$

And by this ſame Rule if you will extract the root of 4, then give me but leave to ſay that the root of 4 is but 1, and then the remainer is 3; and I ſet it down thus:

Oh dunce.

Number	Root	Remainer
4	1	$\frac{3}{3}$

And although this be an improper root, yet you ſee it is the true value of the root of 4, for $\frac{3}{3}$ makes 1 whole, which being added to the root above, makes

makes it 2. Therefore I ſet it down thus:

Number	Root	Remainer
4	2	0

Which is the true root, and yet but the ſame in value with that above: The next Square number to 4 is 9; now all the numbers betwixt 4 and 9 are not Square numbers, and ſubſtract 4 from 9, and there remains 5; but leave out both the Square numbers, and there are but four numbers betwixt the two Square numbers, that is 5, 6, 7, 8. Now theſe four numbers are not Square numbers, for to the root of them there will be a remainer, which remainer encreaſes as the number encreaſes, but the root is the ſame, and common to them all; ſo alſo is the denominator the ſame, and common to them all; only the remainer increaſes, till you come at the next Square number, which is 9. Now the root to them all is 2, and the denominator to them all is 5; therefore I ſet down the numbers, root and remainer thus:

Num-

Number	Root	Remainer
5	2	$\frac{1}{5}$
Number	Root	Remainer
6	2	$\frac{2}{5}$
Number	Root	Remainer
7	2	$\frac{3}{5}$
Number	Root	Remainer
8	2	$\frac{4}{5}$

Now if you would give me leave to ſet down 2 for the root of 9, then the remainer would be 5, and the denominator 5, which makes $\frac{5}{5}$, or 1 whole, which is equal in value to 3, which is the root of 9; and thus if you will go on to hundreds, or to thouſands, or to millions, it fails not, always ſubſtracting the leſſer Square number from the next greater Square number, and the remainer is the true denominator to all the numbers betwixt thoſe two Square numbers: The next Square number to 9 is 16, ſubſtract 9 from 16, and there remains 7; therefore 7 is the common denominator, and 2 is the common root to thoſe ſix numbers betwixt

twixt 9 and 16, only the numerator or remainer increaſes, as the number increaſes, till you come at 16; and I ſet it down thus.

Number	Root	Remainer
9	3	0
10	3	$\frac{1}{7}$
11	3	$\frac{2}{7}$
12	3	$\frac{3}{7}$
13	3	$\frac{4}{7}$
14	3	$\frac{5}{7}$
15	3	$\frac{6}{7}$
16	4	0

Some able Arithmeticians have granted me this, and this might well ſerve for the proof of the denominators.

I ſhall alſo prove it by broken numbers, by reducing the root and the fraction into a broken number; and ſo to produce the

the first given number, let the number be 262, and in the Table I find the root to be 16, and the fraction $\frac{6}{33}$; now to reduce it, I multiply the root 16 by 32. Here you see I abate one from the denominator; and this is one thing that hath puzzled our Artists, who would allow of no abatement, and therefore could never prove the work. Now my reason for abating always 1 from the denominator, is this; 33 is the true denominator, for it is not here as it is in Division, the remainer of a Division is always the numerator to the divisor, but in the extracting the root, the numerator takes no notice of the divisor: But it is a part of that number, which adds one unite to the root, as it is here; 33 is the number, which being added to the Square number, 256, makes 289, which is the next Square number, the root whereof is 17. Here you see that 33 adds one unite to the root, therefore all the remainers from 256, until you come to 289, are parts of 33. Now for the abating of one unite from the denominator 33, for it takes in one of the Square numbers, for there are but 32

num-

numbers betwixt the two Square numbers, and it is only thoſe 32 numbers that have remainers; therefore I reduce the remainer and 32, with the root; alſo if you double the root 16, it makes 32, which is one leſs than 33, the true denominator, and thus of all other: Therefore to return to my work, I reduce the root 16, and the fraction $\frac{6}{32}$, into a broken number, and work it as broken numbers.

You ſee I have given a reaſon why I abate one from the denominator, that is, becauſe I leave out both the Square numbers, and thoſe only are the numbers that have remainers, and it is always one leſs than the denominator; or double the root, and it alſo is one leſs, and then reduce the root and the fraction, and it exactly produces the firſt given number. Now our Artiſts would admit of adding one to the numerator, if that would ſerve, although they could give no reaſon for it; but they will not allow me to ſubſtract one from the denominator, although I give a reaſon, which doth ſerve, and hit juſt right, in all numbers, which they could not find out. Alſo in extracting the root of a

num-

number that hath 2 or 3 figures in the Quotient, you have ſo many diviſors as there are figures in the Quotient, and every ſeveral diviſor you multiply by the figure found in the Quotient, and then you make a ſubſtraction, but, by your leave, you add to the product of the multiplication the ſquare of the figure in the Quotient, and then you make your Subſtraction: And although this addition be put to every ſeveral diviſor, yet it is granted to be the true root, and the true remainer; therefore, I ſay, that abating only once the ſquare of the remainer from the product of the greater multiplication, be it little or great, it always hits right to produce the firſt number, and ſo proves the denominator to be true. Now being fully ſatisfied of the denominators, you may ſave your ſelf that trouble, and you may prove any work in the Table, by multiplying the root in it ſelf, and adding thereto the remainer.

Alſo you will find in the Book what excellent uſe the denominators in the Table are of, which might well ſerve for an anſwer to the Objecters againſt them. I have both troubled my ſelf and my Book

with three or four leaves to answer Criticks, who will cavil at that which they cannot do themselves.

Now Logarithms lowre your sail,
And Algebra give place,
For here is found, that ne'er doth fail,
A nearer way, to your disgrace.

Reduce the root and the remainer $16\frac{6}{32}$.

16	268288		32	518
32	518	518	32	518
32	32	32	64	4144
48	1024		96	518
512			1024	2590
6				268324
518				36
				268288

20
32
444
268288 (262
102444
1022
16

Here I have reduced the root and the remainer into a broken number, and multiplied

tiplied as broken numbers, and from the product of the greateſt multiplication, which is now my dividend, I abate the ſquare of the remainer of the root 6, the ſquare of 6 being 36, I abate from 268324, and there remains 268288 for my dividend, and the product of the leſs multiplication being 1024 is my diviſor, which diviſion produces 262, the firſt given number; and thus of all other. Two or three proofs more will make it more plain: To prove the remainer of the root, you muſt double the root, and it will be always one leſs than the true denominator, and place it under the remainer, and then reduce it and the root into a broken number, as I have done in the laſt proof.

Another Queſtion proved.

Number	Root	Remainer
286	16	$\frac{30}{32}$

As in the former proof I doubled the root, ſo I do here, and it is one leſs than the true denominator; then I reduce it

and the root into a broken number, as here is done.

16	292864		32	542
32	542	542	32	542
32	32	32	64	1084
48	1024		96	2168
512			1024	2710
30				293764
542				900
				292864

1
642
8804
292864 (286. The first given number 286 is here produced in the Quotient.
102444
1022
10

Becauſe I would have you fully ſatisfied of the true value of the remainer, I will prove another or two, and then go on to practiſe with this Rule of the ſquare root.

Num-

Number	Root	Remainer
10067	100	$\frac{67}{201}$

Double or multiply the root by 2, and it is 200, then reduce 100, $\frac{67}{200}$

100 $\frac{67}{200}$ 100
200
000
000
200
20000
67
20067

20067
20067
140469
120402
00000
00000
40134
402684489
4489
402680000

402680000
20067 20067
200 200
40000

200
200
000
000
400
40000

2
402680000 (10067
44444|0000

Here I find the firſt given number in this Quotient.

I ſhall prove one more, and that is 10198, the root of it is 100, and the remainer is $\frac{198}{1}$, as you may find it in the Table: Now to prove it, double the root, and you will find it one leſs than the true denominator, which you muſt always in the proof take for the denominator, then reduce the root 100 $\frac{198}{0}$, into a broken number, and you will find $\frac{20198}{200}$ which multiply as broken numbers, and the product of the greater multiplication is 407959204, from which ſubſtract the ſquare of the remainer 198, the ſquare of it is 39204, from the greateſt product, and the remainer is 407920000 for your dividend, and your leſſer multiplication amounts to 40000 for your diviſor, which diviſion produces the firſt given number 10198, as appears by Practice here following. This may be ſufficient for the proof of the true value of the remainer.

Num-

Number	Root	Remainer $\frac{198}{201}$
10198	100	$\frac{198}{200}$
	2	
	200	

100
200
000
000
200
20000
198
20198

407920000
20198 20198
200 200
40000

20198
20198
200 161584
200 181782
000 20198
000 00000
400 40396
40000 407959204
39204
407920000

33
407920000 (10198 Here I find the first given number.
44444|0000

What I have already ſaid of the proof, is to prove the truth of the Rule, that is, to prove this to be the true denominator to the numerator, and ſo to be the true value of the remainer. Which you ſee I have proved exactly by broken numbers, now being fully ſatisfied of the truth of the denominator, you may ſave your ſelf the trouble of thoſe proofs, and find the denominator thus: Let 256 be the number, now obſerve that it is a Square number, and therefore there is no remainer to the root, and ſo needs no denominator, but all the numbers from this to the next Square number, which is 289 are all of them not Square numbers; therefore ſubſtract the leſs Square number from the greater Square number, and the remainer is the true denominator to all thoſe numbers betwixt the two Square numbers; or more plain, the remainer is the true denominator to the remainer of the root of all thoſe numbers betwixt 256 and

289;

289; for obſerve, as the number increaſes, from 256 to 289, ſo the remainer increaſes, but one denominator ſerves to them all, and one root ſerves to them all, as you may ſee in the Table: For 16 is the root to them all, and 33 is the denominator to them all, only the numerator increaſes as I have ſaid, and thus of all other numbers; the Table will ſave you this labour, alſo for both the root and denominator is ready ſet down to your Eye.

And before we proceed any further, take my advice if you will, that is, if you have a Journey to ride and would buy a Horſe, do not chuſe one only becauſe he is very Fat and Handſom, leſt he fail you in your Journey; but rather chuſe one that goes well, and will carry you with eaſe, and after a little tryal you are ſure will perform his Journey.

And if you are a Batchelor, give me leave to Joke a little with you: If you are about to chooſe a Wife for your ſelf, do not altogether chuſe one for her fine Clothes, leaſt you find your miſtake after, but rather chuſe one vertuous, for ſhe will do you good all the daies of your life. *Eccleſ.*

Eccleſ. 31. 12. And if you get ſuch a Wife, give God the praiſe of it.

Now alſo I adviſe you, not to deſpiſe this work, for the meanneſs of the dreſs it comes forth in, or, for the plainneſs of it, but rather make uſe of it, for the eaſe and great advantage that you will find thereby, and I hope you will affect this the more for Country's ſake, and that you will rejoyce that you are not beholden to a Stranger or Foreigner for it but you have it from an Engliſh Man and a true Subject to our King, for whom I Pray, being in Duty bound, by Gods Command, for long Life, Health, Peace and Proſperity in this World, and in the World to come Eternal Life. *Amen*

Here followeth a uſeful Table of the Square root, where you may readily with eaſe, find the content, or ſquare of the ſide or root of any number to 1488400, or having a number, you may find the root of it: This Table is very plain and eaſie every Leaf, Side or Page, being divided into three Columns or Spaces; in the firſt, is ſet down the ſquare number, in the ſecond, is ſet down the root, in the third,

hird, is ſet down the true denominator to the remainer of all the numbers from that ſquare number to the next ſquare number, and with an eaſie ſubſtraction, taking but the ſquare number from the given number, and ſo you have the remainer belonging to the root of that given number, and the Table ſhews you he denominator to it, and alſo the root of that number: Example, Let 14886 be a number given, and you would know he root of it, and it is not in the Table, being not a ſquare number, but the root of it, and the denominator to it is in the Table, and do but ſubſtract the next ſquare number in the Table, that is leſs han it, from it, being 14884, and there emains 2: Thus you have

Number	Root	Remainer
14886	122	$\frac{2}{245}$

The Uſe of the Square Root.

FIrſt, to make a ſquare two or three times bigger than another Square: irſt Square the ſide thereof, and ſo find he content, which being doubled, trebled,

or

or quadrupled, multiplied by 2, 3, or by 4, and the root thereof taken out of the Table, ſhews the ſide of the Square deſired. Thus the ſide of a Square being 10 look in the Table, and you will find the Content or Square thereof to be 100 which multiplied by 2 makes 200, and the Table ſhews you the root of 200 to be $14\frac{4}{29}$; for the number 200 not being in the Table, according to my former directions, take the next Square number that is leſs than the given number, which here is 196, and the root of it is 14, which 14 with ſome remainer, ſtands for the root of all thoſe numbers till you come to the next Square number, which is 225, the root whereof is 15, which 15 ſerves for the root of all the numbers that are not Square, till you come to the next Square number in the Table. Thus far for directions in the uſe of the Table. But to return to my queſtion, I find in the Table 14 to be the root, and 29 in the Table towards the Right Hand for the denominator, and according to my former directions, I ſubſtract this Square number in the Table 196, from the given number

200

200, that is not Square, and the remainer is 4; Therefore I ſet down my work thus;

Number	Root	Remainer
200	14	$\frac{4}{29}$

Here I find that the root or ſide of the Square that is double to 10, the ſide of it is $14\frac{4}{29}$ the juſt root; now $\frac{4}{29}$ cannot be abbrevied, being a little more than half a quarter, or $\frac{1}{8}$ part to be added to the root 14; yet it is not ſo much as $\frac{1}{7}$ part: But as I have ſaid, the juſt root is, $14\frac{4}{29}$, and in this very work the Seamans Calendar makes his own words good; for, he ſaith, None as yet could ever attain to the knowledge of the true value of the remainer of the root; and in this very work he hath miſt, for he gives it in to be 14 parts, and it is but $\frac{4}{29}$, that is leſs than $\frac{1}{7}$ part.

Another: I deſire to know the ſide of the Square, that is treble to 10, the ſquare of 10 is 100, which multiplied by 3, makes 300; and in the Table you will find the root of 300 to be 17; and towards the right hand, you will find 35

for

for the denominator, then ſubſtract 28 the Square number, which you ſee in th Table, from the given number 30 which is not a Square number, and yo will find the remainer to be 11 : There fore I ſet down my work thus;

Number	Root	Remainer
300	17	$\frac{11}{35}$

Here by my Table, and a little Sub ſtraction, I find the ſide of the ſquar that is treble to ten is 17 $\frac{11}{35}$ parts, whic fraction is ſomething leſs than one thir part: And here again the Kalendar out, for he gives it to be 32 parts.

One queſtion more of this ſort: I de ſire to know the ſide of the ſquare, that ſeven times as big as the firſt; Now th ſquare of the firſt was 100, which mu tiplied by 7, gives you the ſquare of th to be 700, which is not a ſquare numbe in the Table; therefore take the ſquar number in the Table neareſt to it, an leſs than it, and you will find it to b 676, and towards the right hand 26 fo the root, and 53 for the denominator ther

then I ſubſtract that ſquare number found in my Table 676, from the given number 700, and there remains 24; therefore I ſet down my work thus:

Number	Root	Remainer
700	26	$\frac{24}{53}$

Thus, with a very little labour, I find the ſide of this ſquare, which is ſeven times ſo big as the other, to be $26\frac{24}{53}$ *fere*; which fraction cannot be abbrevied; but if you double the root, or abate but one from the denominator, then it may be abbrevied to $\frac{6}{13}$, therefore it is very little leſs than $\frac{6}{13}$, but the juſt root is $26\frac{24}{53}$.

And here I ſet down a Queſtion that I find in the compleat Canonier, and he bids mark it ſeriouſly, for it is not ordinary, and he ſaith, You ſhall find more exquiſite work than you imagine, becauſe the queſtion is more difficult, ſaith he.

This is the Queſtion: A General hath Three Armies in the Field,

In the Firſt is 10296 men.
In the Second is 9493 men.
In the Third is 8500 men.

And

and he would put them in three ſquare Battels, now I find the number of each Army in the Table, with the root and the denominator, and ſet them down without further trouble.

	Number	Root	Remainer
First,	10296	101	$\frac{95}{203}$
	Number	Root	Remainer
Second,	9493	97	$\frac{84}{195}$
	Number	Root	Remainer
Third,	8500	92	$\frac{63}{185}$

Here is readily, and with eaſe, found what was deſired, for here is the root which brings every Army into a ſquare Battel; here is alſo the remainer and denominator to it, and that was it that put him to all the trouble, for he wanted the denominator to his remainer.

Now I ſet down the remainers, and add them together, and it is 242 men, then I ſubſtract 203, which is the denominator to the firſt Army, and there remains 39

men, and thoſe 203 men, which I take from the remainers, I add to the firſt Army, and then the root, or front, and ſide of it will be 102, and the 39 odd men may be employed otherwiſe, for 39 men are far ſhort of making either of the other two Armies ſquare, becauſe the denominator of the fraction is the number that muſt make them ſquare, and you ſee that one denominator is 195, and the other is 185; alſo you ſee what I have added to the firſt Army is juſt his denominator to the fraction, that is 203, which encreaſes the root but one unite.

Another Queſtion in the Canonier, which he hath ſet down, but leaves it not finiſhed, for the Rule being both tedious, and the value of the remainer not found out; for he ſheweth before in his Book how to come near, and to gueſs within leſs than ordinarily is known; and he doth very well in ſaying it is but a gueſs, and yet his way of a gueſs of the remainer is more tedious than all the Queſtion beſides; and when all their labour is ſpent it is but a gueſs; for what value can be put upon the remainer, when they

know not the denominator to it? for which reaſon this excellent Rule of the Square Root hath been much laid aſide: But to return to the Queſtion, it is this; A General had an Army in the Field, and convenient ground for them, containing 44100 foot of ground, the root or ſide thereof is 210, and doubling his Army, he would know what quantity of ground will now ſerve to place his Army in a Square Battel.

Firſt, find the root in the Table 210, and with it, towards your left hand, is the Square of it; double the Square ——— and it is 88200; now this comes very near to the next ſquare number, within nine foot of ground, which is but one ſquare yard yet to work it truly and exactly, and it is but a very little more labour, only one Subſtraction; we muſt take the ſquare number in the Table that is leſs than it that is 87616, and ſubſtract this ſquare number from it, and there remains 584 and the Table gives you the denominator 593; and I ſet down the work thus:

44100	
2	
88200	

Nu

Number	Root	Remainer
88200	296	$\frac{84}{592}$

Here you have the juſt quantity of ground that will contain his Army, being doubled; now nine foot of ground, that is, one ſquare yard, would have made the number Square, that is 88209, and the root would have been one unite more, that is 297, and no remainer: All this is readily found in the Table.

As you work the ſquare, ſo you may work the circle; knowing the diameter, or the circumference thereof, ſquare it, that is, multiply it in it ſelf, and then double or treble it, or multiply it by any other number that you deſire to have the bigneſs of your circle, and extract the ſquare root thereof, ſo you ſhall have the diameter or circumference of the other circle that you deſire; thus the diameter of a circle being 7 inches, the ſquare thereof 49, the double thereof 98, look in the Table, and you will find the root thereof to be 9; and the denominator 19, now 98 is not in the Table,

therefore ſubſtract the next ſquare number that is leſs than it, which in the Table you will find to be 81, from it, and the remainer is 17, the Table gives you the root and the denominator, and Subſtraction gives you the numerator; therefore I ſet down my work thus:

Number	Root	Remainer
98	9	$\frac{17}{19}$

Thus I find that a circle 7 inches diameter, another circle double to it will be 9 inches and $\frac{17}{19}$ parts; thus you may find the weight and ſtrength of any Cable, by comparing it with another, whoſe weight and compaſs you know.

I would know the diameter of the Cable that is four times the ſtrength of one whoſe diameter is 7 inches, the ſquare of 7 is 49, which multiplied by 4, produceth 196, being a ſquare number, it is in the Table, and the root of it towards the right hand 14; and I ſet it down thus:

Number	Root
196	14

Here I find that a Cable, whoſe diameter

meter is 14 inches, will be four times the ſtrength, and weigh four times the weight of the Cable, whoſe diameter is 7 inches, yard for yard; and this is readily done, for the Table ſhews it, without farther trouble; for being a ſquare number, here needs no Subſtraction, becauſe there is no remainer.

Suppoſe a Rope to be 1 $\frac{1}{8}$ inch diameter, and another is required double the ſtrength, now I demand the diameter of the ſaid Rope; This Queſtion was put to me in Writing, and they had toyled about it, and ſcribbled much Paper, but could not finiſh it.

Now here is the Queſtion readily anſwered, 1 $\frac{1}{8}$ is $\frac{9}{8}$, and the Table ſhews you the Square of 9 to be 81, which douled, is 162; and the Table ſhews you the root of it to be 12 $\frac{18}{25}$; now obſerve that the firſt number 1 $\frac{1}{8}$, was reduced into eights, therefore this 12 muſt be divided by 8, and you will find in the Quotient 1 $\frac{1}{2}$ inch, to which you muſt add $\frac{8}{25}$ of $\frac{1}{8}$ of an inch.

So that the diameter of the Rope deſired is 1 $\frac{1}{2}$ inch, and $\frac{8}{25}$ of $\frac{1}{8}$ of an inch.

Again, I ſet the queſtion down more plain, and it is readily anſwered by the Table of the ſquare root thus, $1\frac{1}{8}$ is $\frac{9}{8}$, and the Table ſhews you the Square of 9 to be 81, and becauſe this Rope muſt be double in ſtrength to the other, therefore double 81 and it is 162, and the Table ſhews the root to be $12\frac{18}{25}$; ſo that the diameter of the Rope deſired is one inch and one half inch, and near $\frac{3}{4}$ of $\frac{1}{8}$ part of an inch; and here I ſhall take it out of the Table, and give you readily the diameter of a Rope double, and of a Rope treble and of one four times the ſtrength of the firſt.

$$\begin{array}{r} 81 \\ 81 \\ \hline 162 \end{array}$$

		Number	Root	Remaine
$1\frac{1}{8}\left[\frac{9}{8}\right.$	Nine	81	9	0
	Double	162	12	$\frac{18}{25}$
	Treble	243	15	$\frac{18}{31}$
	Quadruple	324	18	0

In the foregoing Queſtion of a Rope whoſe diameter is $1\frac{1}{8}$, I have ſhewed the diameter of another double, and of one treble, and of one quadruple, or four times

times the ſtrength of the firſt Rope, and you ſee that four times the ſtrength is but double the diameter, for the laſt diameter is 18, which divide by 8, and you have 2 $\frac{2}{8}$ inches for the diameter, which is double to the firſt, and four times the ſtrength. Again, I will multiply, the firſt diameter 1 $\frac{1}{8}$ by 5, and by 6, by 7, by 8, and by 9; and give you the ſeveral diameters of them all, which is readily done by the Table.

		Number	Root	Remainer
1 $\frac{1}{8}$ | $\frac{2}{8}$ | 81	Five	405	20	$\frac{5}{41}$
	Six	486	22	$\frac{2}{45}$
	Seven	567	23	$\frac{38}{47}$
	Eight	648	25	$\frac{23}{51}$
	Nine	729	27	00

Here you ſee that 9 times the ſtrength is but three times the diameter, for divide 27 by 8, and you may have 3 $\frac{3}{8}$ inches, which is treble the firſt given diameter.

I have already given you the diameter of a Rope that is nine times the ſtrength of the firſt Rope, and becauſe I would

have my Country men expert in ſuch things, and alſo that it is rather a recreation, than any toyl or labour, to anſwer any ſuch Queſtion by this Table, being ſo plain, eaſie, and ready a way of working; and alſo that you may know that the Table will anſwer a ſmall Queſtion as well as a great, I ſhall therefore give you the diameter of a Rope that is but a little ſtronger than the firſt Rope, therefore I will add to the ſtrength of the firſt Rope but $\frac{3}{8}$ parts, and I would know the diameter of it. Now the diameter of the firſt Rope was $\frac{9}{8}$, and the Square of it the Table ſhews you to be 81, and becauſe I would have another but $\frac{3}{8}$ ſtronger, I find in the Table the Square of 3 to be 9, then I add thoſe two Squares together, 81 and 9, and they make 90: Then I look in the Table for the root of 90; and being that it is not a Square number, therefore I take the number in the Table that is leſs than it which is 81, and I ſubſtract it from 90 and there remains 9, for the numerato and the Table ſhews the denominator t be 19, and the root to be nine; and I ſe it down thus:

81
9
90

Num

Number	Root	Remainer
90	9	$\frac{9}{17}$

Now divide the root by 8, and you will find the diameter of the Rope desired, to be 1 inch and $\frac{1}{8}$ of one inch, and $\frac{9}{17}$ of one eighth of an inch. Thus you may increaſe the ſtrength of a Rope or Cable, as you pleaſe, and as you may increaſe the ſtrength, ſo you may decreaſe, or diminiſh, or abate from the ſtrength; for when you would increaſe, you multiply the Square of the diameter by 2, or 3, or by 4, ſo do but divide the Square of the diameter by any number or figure, according as you would have the ſtrength of the Cable abated, and the root of the Quotient is the diameter of the Table deſired. And for your farther inſtruction, take notice that the laſt work of the ſmall Rope, whoſe diameter was $\frac{9}{8}$, and another was deſired $\frac{1}{8}$ ſtronger; now theſe two fractions are both of one like denomination, for 8 is the denominator to them both, which after is your diviſor, but if they be of ſeveral denominations, then

then they must be reduced into a common denomination, and that common denominator shall be the divisor; as for example; One small Rope being $\frac{9}{8}$ of an inch diameter, another is desired $\frac{3}{4}$ more in strength, now these two fractions are of unlike denominations, for the one is eights and the other fourths, therefore I reduce them into a common denomination.

36 24
9 X 3
8 X 4
32

Now I have 32 for my denominator, and 36 and 24 for my two fractions, therefore I look in the Table for the square of 36, and I find 1296; then again I look in the Table for the square of 24, and I find 1024, then I add those two Squares together, and it amounts to 2320, Then I look in the Table for the root of this addition, and I find the root of 2320 to be 48 $\frac{16}{97}$, therefore, as I said before, I divide 48 by my common divisor 32, and the Quotient is 1, and 16 remains. Thus I find the diameter of the Rope desired, to be 1 inch, and $\frac{16}{32}$

1296
1024
2320

16
48 (1
32

of

of an inch, and $\frac{16}{97}$ of one 32 of an inch.

Alſo for Triangles, having the perpendicular and baſe, you may readily find the ſlope-line, or hypothenuſe. For Example: A Triangle, whoſe perpendicular is 36, and the baſe 43, what is the hypothenuſe? In the Table you will find the ſquare of 36 to be 1296; and the ſquare of 43 to be 1849; add thoſe two ſquares together and it amounts to 3145, which is the ſquare of the hypothenuſe; and the Table ſhews you the root thereof to be 56 $\frac{9}{111}$, which is the true length of the ſlope-line.

	1296
	1849
	3145

Again, Having the ſlope-line and the perpendicular, you may find the baſe, the ſlope-line 87, the perpendicular 33, you will find in the Table the ſquare of 87 to be 7569, and the ſquare of 33 to be 1089, which ſubſtracted, there remains 6480; for the ſquare of the baſe, and the Table, ſhews the root of it to be 80 $\frac{80}{161}$, for according to my former directions, the Table gives you the denominator, and Subſtraction

	7569
	1089
	6480

ction gives you the numerator: After the ſame way you may find the perpendicular; for ſubſtract the ſquare of the baſe line from the ſquare of the ſlope line, and the remainer is the ſquare of the perpendicular, and the root of that laſt ſquare is the true perpendicular, and you may readily find the root of any number in the Table; or having the root, you may readily find the ſquare of it in the Table; for all ſquare numbers to 1488400 are in the Table, and the root of them joyning with them, towards the right hand; and for thoſe that are not ſquare numbers, you have both the root and denominator belonging to the remainer in the Table. For Example; 484 is a ſquare number, and 22 is the root of it, you will find them both together in the Table, and the next ſquare number in the Table is 529. Now there are 44 numbers betwixt 484 and 529, and all of them are not ſquare numbers, therefore they have remainers to the root of them, which is eaſily found by the Table; for if the given number be not a ſquare number, and therefore not in the Table; as for Example, Let it be

527,

527, then take the next ſquare number in the Table, that is leſs than it, as 529 is neareſt in the Table to it, but it is more than the given number, therefore you muſt take 484, and ſubſtract it from the given number 527, and there will remain 43; then obſerve that the root of 484 is 22, and it is alſo the root of this given number 527, with this remainer 43, and its denominator is 45; therefore I place it thus:

The Number	Root	Remainer
527	22	$\frac{43}{45}$

Theſe Directions obſerved, the root of any number is eaſily found by the Table.

How to find the Square of a whole Number, and broken.

BY this Table of the ſquare root you may readily find the ſquare of any whole number, and broken, of any number that hath a fraction joyned to it. Let the number be $838\frac{2}{3}$, look in the Table for

for the root 838, and to the left hand of it you have the Square of it 702244, and to the right hand of it you have the denominator to it 1677; and becauſe your fraction was $\frac{2}{3}$, therefore you muſt take the two thirds of the denominator found in the Table, and add it to the Square of the whole number; and ſo you have the Square of the whole and broken of $838\frac{2}{3}$. Thus in the Table you will find the denominator is 1677, which multiply by the numerator of the fraction 2, and divide the product by the denominator of the fraction 3, and the Quotient is 1118, which is the Square of the fraction deſired. Which being added to the Square of the firſt ſumm, to the Square of 838, which was 702244, and it amounts to 703362 for the Square of the firſt given number $838\frac{2}{3}$: And thus you may readily find the Square of any whole number and broken, as it is by practice here ſet down.

1677

1677
2
3354

x
3354 (1118
3333

702244
1118
703362

Here you may ſee how uſeful the finding out of this ſecret is, the finding of the true denominator, and thereby the true value of the remainer, and that alſo ſo readily, and with eaſe, which makes the rule delightſom; the denominators in the Table are of excellent uſe, thereby to find the Square of any fraction readily, and with eaſe.

Another Queſtion: What is the Square of 476 $\frac{4}{5}$? In the Table you may find the root 476, and with it, to the left hand, you have the Square of it 226576, and to the right hand of it, you have the denominator 953, then multiply this denominator found in the Table, by the numerator of the fraction 4, and the product is 3812; which divide by the denominator of the fraction 5, and the Quo-

Quotient is $762\frac{2}{5}$, for the Square of the fraction desired; which being added to the Square of the first summ, to the Square of 476, which was 226576; it amounts to $227338\frac{2}{5}$, which is the Square of the first given number $476\frac{4}{5}$.

953
4
3812

3 1 (2
38 1 2 (762 $\frac{2}{5}$
1 1 1

226576
762 $\frac{2}{5}$
227388 $\frac{2}{5}$

Number or Square.	The Root	The Denominator.
001	01	03
— 004	02	05
009	03	07
016	04	09
025	05	11
036	06	13
049	07	15
— 064	08	17
081	09	19
100	10	21
121	11	23
144	12	25
169	13	27
— 196	14	29
225	15	31.
256	16	33

Square	Root	Denominat.
289	17	35
324	18	37
361	19	39
400	20	41
441	21	43
484	22	45
529	23	47
576	24	49
625	25	51
676	26	53
729	27	55
784	28	57
841	29	59
900	30	61
961	31	63
1024	32	65

Square	Root	Denominat.
1089	33	67
1156	34	69
1225	35	71
1296	36	73
1369	37	75
1444	38	77
1521	39	79
1600	40	81
1681	41	83
1764	42	85
1849	43	87
1936	44	89
2025	45	91
2116	46	93
2209	47	95
2304	48	97

Square	Root	Denominat.
2401	49	99
2500	50	101
2602	51	103
2704	52	105
2809	53	107
2916	54	109
3025	55	111
3136	56	113
3249	57	115
3364	58	117
3481	59	119
3600	60	121
3721	61	123
3844	62	125
3969	63	127
4096	64	129

Square	Root	Denominat.
4225	65	131
4356	66	133
4489	67	135
4624	68	137
4761	69	139
4900	70	141
5041	71	143
5184	72	145
5329	73	147
5476	54	149
5625	75	151
5776	76	153
5929	77	155
6084	78	157
6241	79	159
6400	80	161

Square	Root	Denominat.
6561	81	163
6724	82	165
6889	83	167
7056	84	169
7225	85	171
7396	86	173
7569	87	175
7744	88	177
7921	89	179
8100	90	181
8281	91	183
8464	92	185
8649	93	187
8836	94	189
9025	95	191
9216	96	193

Square	Root	Denominat.
9409	97	195
9604	98	197
9801	99	199
10000	100	201
10201	101	203
10404	102	205
10609	103	207
10816	104	209
11025	105	211
11239	106	213
11449	107	215
11664	108	217
11881	109	219
12100	110	221
12321	111	223
12544	112	225

Square	Root	Denominat.
12769	113	227
12996	114	229
13225	115	231
13456	116	233
13689	117	235
13924	118	237
14161	119	239
14400	120	241
14641	121	243
14884	122	245
15129	123	247
15376	124	249
15625	125	251
15876	126	253
16129	127	255
16384	128	357

Square	Root	Denominat.
16641	129	259
16900	130	261
17161	131	263
17424	132	265
17689	133	267
17956	134	269
18225	135	271
18496	136	273
18769	137	275
19044	138	277
19321	139	279
19600	140	281
19881	141	283
20164	142	285
20449	143	287
20736	144	289

Square	Root	Denominat.
21025	145	291
21316	146	293
21609	147	295
21904	148	297
22201	149	299
22500	150	301
22801	151	303
23104	152	305
23409	153	307
23716	154	309
24025	155	311
24336	156	313
24649	157	315
24964	158	317
25281	159	319
25600	160	321

Square	Root	Denominat.
25921	161	323
26244	162	325
26569	163	327
26896	164	329
27225	165	331
27556	166	333
27889	167	335
28224	168	337
28561	169	339
28900	170	341
29241	171	343
29584	172	345
29929	173	347
30276	174	349
30625	175	351
30976	176	353

Square	Root	Denominat.
31329	177	355
31684	178	357
32041	179	359
32400	180	361
32761	181	363
33124	182	365
33489	183	367
33856	184	369
34225	185	371
34596	186	373
34969	187	375
35344	188	377
35721	189	379
36100	190	381
36481	191	383
36864	192	385

Square	Root	Denominat.
37249	193	387
37636	194	389
38025	195	391
38446	196	393
38809	197	395
39204	198	397
39601	199	399
40000	200	401
40401	201	403
40804	202	405
41209	203	407
41616	204	409
42025	205	411
42436	206	413
42849	207	415
43264	208	417

Square	Root	Denominat.
43681	209	419
44100	210	421
44521	211	423
44944	212	425
45369	213	427
45796	214	429
46225	215	431
46656	216	433
47089	217	435
47524	218	437
47961	219	439
48400	220	441
48841	221	443
49284	222	445
49729	223	447
50176	224	449

Square	Root	Denominat.
50625	225	451
51076	226	453
51529	227	455
51984	228	457
52441	229	459
52900	230	461
53361	231	463
53824	232	465
54289	233	467
54756	234	469
55225	235	471
55696	236	473
56169	237	475
56644	238	477
57121	239	479
57600	240	481

Square	Root	Denominat.
58081	241	483
58564	242	485
59049	243	487
59536	244	489
60025	245	491
60516	246	493
61009	247	495
61504	248	497
62001	249	499
62500	250	501
63001	251	503
63504	252	505
64009	253	507
64516	254	509
65025	255	511
65536	256	513

Square	Root	Denominat.
66049	257	515
66564	258	517
67081	259	519
67600	260	521
68121	261	523
68644	262	525
69169	263	527
69696	264	529
70225	265	531
70756	266	533
71289	267	535
71824	268	537
72361	269	539
72900	270	541
73441	271	543
73984	272	545

Square	Root	Denominat.
74529	273	547
75076	274	549
75625	275	551
76176	276	553
76729	277	555
77284	278	557
77841	279	559
78400	280	561
78961	281	563
79524	282	565
80089	283	567
80656	284	569
81225	285	571
81796	286	573
82369	287	575
82944	288	577

Square	Root	Denominat.
83521	289	579
84100	290	581
84681	291	583
85264	292	585
85849	293	587
86436	294	589
87025	295	591
87616	296	593
88209	297	595
88804	298	597
89401	299	599
90000	300	601
90601	301	603
91204	302	605
91809	303	607
92416	304	609

Square	Root	Denominat.
93025	305	611
93636	306	613
94249	307	615
94864	308	617
95481	309	619
96100	310	621
96721	311	623
97344	312	625
97969	313	627
98596	314	629
99225	315	631
99856	316	633
100489	317	635
101124	318	637
101761	319	639
102400	320	641

Square	Root	Denominat.
103041	321	643
103684	322	645
104329	323	647
104976	324	649
105625	325	651
106276	326	653
106929	327	655
107584	328	657
108241	329	659
108900	330	661
109561	331	663
110224	332	665
110889	333	667
111556	334	669
112225	335	671
112896	336	673

Square	Root	Denominat.
113569	337	675
114244	338	677
114921	339	679
115600	340	681
116281	341	683
116964	342	685
117649	343	687
118336	344	689
119025	345	691
119716	346	693
120409	347	695
121104	348	697
121801	349	699
122500	350	701
123201	351	703
123904	352	705

Square	Root	Denominat.
124609	353	707
125316	354	709
126025	355	711
126736	356	713
127449	357	715
128164	358	717
128881	359	719
129600	360	721
130321	361	723
131044	362	725
131769	363	727
132496	364	729
133225	365	731
133956	366	733
134689	367	735
135424	368	737

Square	Root	Denominat.
136161	369	739
136900	370	741
137641	371	743
138384	372	745
139129	373	747
139876	374	749
140625	375	751
141376	376	753
142129	377	755
142884	378	757
143641	379	759
144400	380	761
145161	381	763
145924	382	765
146689	383	767
147456	384	769

Square	Root	Denominat.
148225	385	771
148996	386	773
149769	387	775
150544	388	777
151321	389	779
152100	390	781
152881	391	783
153664	392	785
154449	393	787
155236	394	789
156025	395	791
156816	396	793
157609	397	795
158404	398	797
159201	399	799
160000	400	801

Square	Root	Denominat.
160801	401	803
161604	402	805
162409	403	807
163216	404	809
164025	405	811
164836	406	813
165649	407	815
166464	408	817
167281	409	819
168100	410	821
168921	411	823
169744	412	825
170569	413	827
171396	414	829
172225	415	831
173056	416	833

Square	Root	Denominat.
173889	417	835
174724	418	837
175561	419	839
176400	420	841
177241	421	843
178084	422	845
178929	423	847
179776	424	849
180625	425	851
181476	426	853
182329	427	855
183184	428	857
184041	429	859
184900	430	861
185761	431	863
186624	432	865

Square	Root	Denominat.
187489	433	867
188356	434	869
189225	435	871
190096	436	873
190969	437	875
191844	438	877
192721	439	879
193600	440	881
194481	441	883
195364	442	885
196249	443	887
197136	444	889
198025	445	891
198916	446	893
199809	447	895
200704	448	897

Square	Root	Denominat.
201601	449	899
202500	450	901
203401	451	903
204304	452	905
205209	453	907
206116	454	909
207025	455	911
207936	456	913
208849	457	915
209764	458	917
210681	459	919
211600	460	921
212521	461	923
213444	462	925
214369	463	927
215296	464	929

Square	Root	Denominat.
216225	465	931
217156	466	933
218089	467	935
219024	468	937
219961	469	939
220900	470	941
221841	471	943
222784	472	945
223729	473	947
224676	474	949
225625	475	951
226576	476	953
227529	477	955
228484	478	957
229441	479	959
230400	480	961

Square	Root	Denominat.
231361	481	963
232324	482	965
233289	483	967
234256	484	969
235225	485	971
236196	486	973
237169	487	975
238144	488	977
239121	489	979
240100	490	981
241081	491	983
242064	492	985
243049	493	987
244036	494	989
245025	495	991
246016	496	993

Square	Root	Denominat.
247009	497	995
248004	498	997
249001	499	999
250000	500	1001
251001	501	1003
252004	502	1005
253009	503	1007
254016	504	1009
255025	505	1011
256036	506	1013
257049	507	1015
258064	508	1017
259081	509	1019
260100	510	1021
261121	511	1023
262144	512	1025

Square	Root	Denominat.
263169	513	1027
264196	514	1029
265225	515	1031
266256	516	1033
267289	517	1035
268324	518	1037
269361	519	1039
270400	520	1041
271441	521	1043
272484	522	1045
273529	523	1047
274576	524	1049
275625	525	1051
276676	526	1053
277729	527	1055
278784	528	1057

Square	Root	Denominat.
279841	529	1059
280900	530	1061
281961	531	1063
283024	532	1065
284089	533	1067
285156	534	1069
286225	535	1071.
287296	536	1073
288369	537	1075
289444	538	1077
290521	539	1079
291600	540	1081
292681	541	1083
293764	542	1085
294849	543	1087
295936	544	1089

Square	Root	Denominat.
297025	545	1091
298116	546	1093
299209	547	1095
300304	548	1097
301401	549	1099
302500	550	1101
303601	551	1103
304704	552	1105
305809	553	1107
306916	554	1109
308025	555	1111
309136	556	1113
310249	557	1115
311364	558	1117
312481	559	1119
313600	560	1121

Square	Root	Denominat.
314721	561	1123
315844	562	1125
316969	563	1127
318096	564	1129
319225	565	1131
320356	566	1133
321489	567	1135
322624	568	1137
323761	569	1139
324900	570	1141
326041	571	1143
327184	572	1145
328329	573	1147
329476	574	1149
330625	575	1151
331776	576	1153

Square	Root	Denominat.
332929	577	1155
334084	578	1157
335241	579	1159
336400	580	1161
337561	581	1163
338724	582	1165
339889	583	1167
341056	584	1169
342225	585	1171
343396	586	1173
344569	587	1175
345744	588	1177
346921	589	1179
348100	590	1181
349281	591	1183
350464	592	1185

Square	Root	Denominat.
351649	593	1187
352836	594	1189
354025	595	1191
355216	596	1193
356409	597	1195
357604	598	1197
358801	599	1199
360000	600	1201
361201	601	1203
362404	602	1225
363609	603	1207
364816	604	1209
366025	605	1211
367236	606	1213
368449	607	1215
369664	608	1217

Square	Root	Denominat.
370881	609	1219
372100	610	1221
373321	611	1223
374544	612	1225
375769	613	1227
376996	614	1229
378225	615	1231
379456	616	1233
380689	617	1235
381924	618	1237
383161	619	1239
384400	620	1241
385641	621	1243
386884	622	1245
388129	623	1247
389376	624	1249

Square	Root	Denominat.
390625	625	1251
391876	626	1253
393129	627	1255
394384	628	1257
395641	629	1259
396900	630	1261
398161	631	1263
399424	632	1265
400689	633	1267
401956	634	1269
403225	635	1271
404496	636	1273
405769	637	1275
407044	638	1277
408321	639	1279
409600	640	1281

Square	Root	Denominat.
410881	641	1283
412164	642	1285
413449	643	1287
414736	644	1289
416025	645	1291
417316	646	1293
418609	647	1295
419904	648	1297
421201	649	1299
422500	650	1301
423801	651	1303
425104	652	1305
426409	653	1307
427716	654	1309
429025	655	1311
430336	656	1313

Square	Root	Denominat.
431649	657	1315
432964	658	1317
434281	659	1319
435600	660	1321
436921	661	1323
438244	662	1325
439569	663	1327
440896	664	1329
442225	665	1331
443556	666	1333
444889	667	1335
446224	668	1337
447561	669	1339
448900	670	1341
450241	671	1343
451584	672	1345

Square	Root	Denominat.
452929	673	1347
454276	674	1349
455625	675	1351
456976	676	1353
458329	677	1355
459684	678	1357
461041	679	1359
462400	680	1361
463761	681	1363
465124	682	1365
466489	683	1367
467856	684	1369
469225	685	1371
470596	686	1373
471969	687	1375
473344	688	1377

Square	Root	Denominat.
474721	689	1379
476100	690	1381
477481	691	1383
478864	692	1385
480249	693	1387
481636	694	1389
483025	695	1391
484416	696	1393
485809	697	1395
487204	698	1397
488601	699	1399
490000	700	1401
491401	701	1403
492804	702	1405
494209	703	1407
495616	704	1409

Square	Root	Denominat.
497025	705	1411
498436	706	1413
499849	707	1415
501264	708	1417
502681	709	1419
504100	710	1421
505521	711	1423
506944	712	1425
508369	713	1427
509796	714	1429
511225	715	1431
512656	716	1433
514089	717	1435
515524	718	1437
516961	719	1439
518400	720	1441

Square	Root	Denominat.
519841	721	1443
521284	722	1445
523729	723	1447
524176	724	1449
525625	725	1451
527076	726	1453
528529	727	1455
529984	728	1457
531441	729	1459
532900	730	1461
534361	731	1463
535824	732	1465
537289	733	1467
538756	734	1469
540225	735	1471
541696	736	1473

Square	Root	Denominat.
543169	737	1475
544644	738	1477
546121	739	1479
547600	740	1481
549081	741	1483
550564	742	1485
552049	743	1487
553536	744	1489
555025	745	1491
556516	746	1493
558009	747	1495
559504	748	1497
561001	749	1499
562500	750	1501
564001	751	1503
565504	752	1505

Square	Root	Denominat.
567009	753	1507
568516	754	1509
570025	755	1511
571536	756	1513
573049	757	1515
574564	758	1517
576081	759	1519
577600	760	1521
579121	761	1523
580644	762	1525
582169	763	1527
583696	764	1529
585225	765	1531
586756	766	1533
588289	767	1535
589824	768	1537

Square	Root	Denominat.
591361	769	1539
592900	770	1541
594441	771	1543
595984	772	1545
597529	773	1547
599076	774	1549
600625	775	1551
602176	776	1553
603729	777	1555
605284	778	1557
606841	779	1559
608400	780	1561
609961	781	1563
611524	782	1565
613089	783	1567
614656	784	1569

Square	Root	Denominat.
616225	785	1571
617796	786	1573
619369	787	1575
620944	788	1577
622521	789	1579
624100	790	1581
625681	791	1583
627264	792	1585
628849	793	1587
630436	794	1589
632025	795	1591
633616	796	1593
635209	797	1595
636804	798	1597
638401	799	1599
640000	800	1601

Square	Root	Denominat.
641601	801	1603
643204	802	1605
644809	803	1607
646416	804	1609
648025	805	1611
649636	806	1613
651249	807	1615
652864	808	1617
654481	809	1619
656100	810	1621
657721	811	1623
659344	812	1625
660969	813	1627
662596	814	1629
664225	815	1631
665856	816	1633

Square	Root	Denominat.
667489	817	1635
669124	818	1637
670761	819	1639
672400	820	1641
674041	821	1643
675684	822	1645
677329	823	1647
678976	824	1649
680625	825	1651
682276	826	1653
683929	827	1655
685584	828	1657
687241	829	1659
688900	830	1661
690561	831	1663
692224	832	1665

Square	Root	Denominat.
693889	833	1667
695556	834	1669
697225	835	1671
698896	836	1673
700569	837	1675
702244	838	1677
703921	839	1679
705600	840	1681
707281	841	1683
708964	842	1685
710649	843	1687
712336	844	1689
714025	845	1691
715716	846	1693

Square	Root	Denominat.
717409	847	1695
719104	848	1697
720801	849	1699
722500	850	1701
724201	851	1703
725904	852	1705
727609	853	1707
729316	854	1709
731025	855	1711
732736	856	1713
734449	857	1715
736164	858	1717
737881	859	1719
739600	860	1721
741321	861	1723
743044	862	1725

Square	Root	Denominat.
744769	863	1727
746496	864	1729
748225	865	1731
749956	866	1733
751689	867	1735
753424	868	1737
755161	869	1739
756900	870	1741
758641	871	1743
760384	872	1745
762129	873	1747
763876	874	1749
765625	875	1751
767376	876	1753
769129	877	1755
770884	878	1757

Square	Root	Denominat.
772641	879	1759
774400	880	1761
776161	881	1763
777924	882	1765
779689	883	1767
781456	884	1769
783225	885	1771
784996	886	1773
786769	887	1775
788544	888	1777
790321	889	1779
792100	890	1781
793881	891	1783
795664	892	1785
797449	893	1787
799236	894	1789

Square	Root	Denominat.
801625	895	1791
802816	896	1793
804609	897	1795
806404	898	1797
808201	899	1799
810000	900	1801
811801	901	1803
813604	902	1805
815409	903	1807
817216	904	1809
819025	905	1811
820836	906	1813
822649	907	1815
824464	908	1817
826281	909	1819
828100	910	1821

Square	Root	Denominat.
829921	911	1823
831744	912	1825
833569	913	1827
835396	914	1829
837225	915	1831
839056	916	1833
840889	917	1835
842724	918	1837
844561	919	1839
846400	920	1841
848241	921	1843
850084	922	1845
851929	923	1847
853776	924	1849
855625	925	1851
857476	926	1853

Square	Root	Denominat.
859329	927	1855
861184	928	1857
863041	929	1859
864900	930	1861
866761	931	1863
868624	932	1865
870489	933	1867
872356	934	1869
874225	935	1871
876096	936	1873
877969	937	1875
879844	938	1877
881721	939	1879
883600	940	1881
885481	941	1883
887364	942	1885

Square	Root	Denominat.
889249	943	1887
891136	944	1889
893025	945	1891
894916	946	1893
896809	947	1895
898704	948	1897
900601	949	1899
902500	950	1901
904401	951	1903
906304	952	1905
908209	953	1907
910116	954	1909
912025	955	1911
913936	956	1913
915849	957	1915
917764	958	1917

Square	Root	Denominat.
919681	959	1919
921600	960	1921
923521	961	1923
925444	962	1925
927369	963	1927
929296	964	1929
931225	965	1931
933156	966	1933
935089	967	1935
937024	968	1937
938961	969	1939
940900	970	1941
942841	971	1943
944784	972	1945
946729	973	1947
948676	974	1949

Square	Root	Denominat.
950625	975	1951
952576	976	1953
954529	977	1955
956484	978	1957
958441	979	1959
960400	980	1961
962361	981	1963
964324	982	1965
966289	983	1967
968256	984	1969
970225	985	1971
972196	986	1973
974169	987	1975
976144	988	1977
978121	989	1979
980100	990	1981

Square	Root	Denominat.
982081	991	1983
984064	992	1985
986049	993	1987
988036	994	1989
990025	995	1991
992016	996	1993
994009	997	1995
996004	998	1997
998001	999	1999
1000000	1000	2001
1002001	1001	2003
1004004	1002	2005
1006009	1003	2007
1008016	1004	2009
1010025	1005	2011
1012036	1006	2013

Square	Root	Denominat.
1014049	1007	2015
1016064	1008	2017
1018081	1009	2019
1020100	1010	2021
1022121	1011	2023
1024144	1012	2025
1026169	1013	2027
1028196	1014	2029
1030225	1015	2031
1032256	1016	2033
1034289	1017	2035
1036324	1018	2037
1038361	1019	2039
1040400	1020	2041
1042441	1021	2043
1044484	1022	2045

Square	Root	Denominat.
1046529	1023	2047
1048576	1024	2049
1050625	1025	2051
1052676	1026	2053
1054729	1027	2055
1056784	1028	2057
1058841	1029	2059
1060900	1030	2061
1062961	1031	2063
1065024	1032	2065
1067089	1033	2067
1069156	1034	2069
1071225	1035	2071
1073296	1036	2073
1075369	1037	2075
1077444	1038	2077

Square	Root	Denominat.
1079521	1039	2079
1081600	1040	2081
1083681	1041	2083
1085764	1042	2085
1087849	1043	2087
1089936	1044	2089
1092025	1045	2091
1094116	1046	2093
1096209	1047	2095
1098304	1048	2097
1100401	1049	2099
1102500	1050	2101
1104601	1051	2103
1106704	1052	2105
1108809	1053	2107
1110916	1054	2109

Square	Root	Denominat.
1113025	1055	2111
1115136	1056	2113
1117249	1057	2115
1119364	1058	2117
1121481	1059	2119
1123600	1060	2121
1125721	1061	2123
1127844	1062	2125
1129969	1063	2127
1132096	1064	2129
1134225	1065	2131
1136356	1066	2133
1138489	1067	2135
1140624	1068	2137
1142761	1069	2139
1144900	1070	2141

Square	Root	Denominat.
1147041	1071	2143
1149184	1072	2145
1151329	1073	2147
1153476	1074	2149
1155625	1075	2151
1157776	1076	2153
1159929	1077	2155
1162084	1078	2157
1164241	1079	2159
1166400	1080	2161
1168561	1081	2163
1170724	1082	2165
1172889	1083	2167
1175056	1084	2169
1177225	1085	2171
1179396	1086	2173

Square	Root	Denominat.
1181569	1087	2174
1183744	1088	2177
1185921	1089	2179
1188100	1090	2181
1190281	1091	2183
1192464	1092	2185
1194649	1093	2187
1196836	1094	2189
1199025	1095	2191
1201216	1096	2193
1203409	1097	2195
1205604	1098	2197
1207801	1099	2199
1210000	1100	2201
1212201	1101	2203
1214404	1102	2205

Square	Root	Denominat.
1216609	1103	2207
1218816	1104	2209
1221025	1105	2211
1223236	1106	2213
1225449	1107	2215
1227664	1108	2217
1229881	1109	2219
1232100	1110	2221
1234321	1111	2223
1236544	1112	2225
1238769	1113	2227
1240996	1114	2229
1243225	1115	2231
1245456	1116	2233
1247689	1117	2235
1249924	1118	2237

Square	Root	Denominat.
1252161	1119	2239
1254400	1120	2241
1256641	1121	2243
1258884	1122	2245
1261129	1123	2247
1263376	1124	2249
1265625	1125	2251
1267876	1126	2253
1270129	1127	2255
1272384	1128	2257
1274641	1129	2259
1276900	1130	2261
1279161	1131	2263
1281424	1132	2265
1283689	1133	2267
1285956	1134	2269

Square	Root	Denominat.
1288225	1135	2271
1290496	1136	2273
1292769	1137	2275
1295044	1138	2277
1297321	1139	2279
1299600	1140	2281
1301881	1141	2283
1304164	1142	2285
1306449	1143	2287
1308736	1144	2289
1311025	1145	2291
1313316	1146	2293
1315609	1147	2295
1317904	1148	2297
1320201	1149	2299
1322500	1150	2301

Square	Root	Denominat.
1324801	1151	2303
1327104	1152	2305
1329409	1153	2307
1331716	1154	2309
1334025	1155	2311
1336336	1156	2313
1338649	1157	2315
1340964	1158	2317
1343281	1159	2319
1345600	1160	2321
1347921	1161	2323
1350244	1162	2325
1352569	1163	2327
1354896	1164	2329
1357225	1165	2331
1359556	1166	2333

Square	Root	Denominat.
1361889	1167	2335
1364224	1168	2337
1366561	1169	2339
1368900	1170	2341
1371241	1171	2343
1373584	1172	2345
1375929	1173	2347
1378276	1174	2349
1380625	1175	2351
1382976	1176	2353
1385329	1177	2355
1387684	1178	2357
1390041	1179	2359
1392400	1180	2361
1394761	1181	2363
1397124	1182	2365

Square	Root	Denominat.
1399489	1183	2367
1401856	1184	2369
1404225	1185	2371
1406596	1186	2373
1408969	1187	2375
1411344	1188	2377
1413721	1189	2379
1416100	1190	2381
1418481	1191	2383
1420864	1192	2385
1423249	1193	2387
1425636	1194	2389
1428025	1195	2391
1430416	1196	2393
1432809	1197	2395
1435204	1198	2397

Square	Root	Denominat.
1437601	1199	2399
1440000	1200	2401
1442401	1201	2403
1444804	1202	2405
1447209	1203	2407
1449616	1204	2409
1452025	1205	2411
1454436	1206	2413
1456849	1207	2415
1459264	1208	2417
1461681	1209	2419
1464100	1210	2421
1466521	1211	2423
1468944	1212	2425
1471369	1213	2427
1473796	1214	2429

Square	Root	Denominat.
1476225	1215	2431
1478656	1216	2433
1481089	1217	2435
1483524	1218	2437
1485961	1219	2439
1488400	1220	2441

The Use of this Table of the Square Root in Navigation.

A Mile contains { 1760 Yards, / 5280 Feet,
But it is now found out that one Mile of a great circle contains { 2040 Yards, / 6120 Feet,
but for evenness of measure, is allowed to a Mile { 2000 Yards, / 6000 Feet,
so that 1 degree of a great circle contains 68 miles & $\frac{2}{11}$ parts of a mile, but we may omit the

the fraction, and take 68 miles for a degree of a great circle; and then you may divide the log line, and make it juſt 50 foot betwixt knot and knot; and then running one of thoſe knots in half a minute, the Ship runs a mile in an hour; if two knots in half a minute, then two miles in one hour; if four knots in half a minute, then ſhe runs four miles in one hour: for ſo many knots as the Ship runs in half a minute, ſo many miles ſhe runs in one hour.

To find the diſtance of places, by this Table of the Square Root, knowing their Latitude and Longitude.

I Would know the diſtance betwixt the *Lyzard* and *Barbadoes*.

	Latitude		Longitude	
	♎	---	♎	---
Barbadoes	12	40	328	20
	♎	---	♎	---
Lyzard	50	10	18	30

Their difference Latitude 37 $\frac{30}{68}$ degrees.
Their difference Longitude 50 $\frac{10}{68}$ degrees.

But

But make it 50 $\frac{10}{70}$, and then it will be 50 degrees and $\frac{1}{7}$ part, their difference of Longitude.

Now the Longitude muſt be proportioned by the miles, anſwerable to a degree in the Latitude of the *Lyzard*, and not to the middle Latitude, and in the Latitude of the *Lyzard* 43 $\frac{1}{2}$ miles makes one degree of Longitude.

Therefore you muſt multiply your degrees of difference of Longitude by 43 $\frac{1}{2}$ miles, and you will find it to be 2181 $\frac{1}{2}$ miles, or 727 leagues.

Then multiply your degrees of difference of Latitude by 68, and you will find it to be 2546 miles, or 848 $\frac{2}{3}$ leagues.

Then look in the Table for the ſquare of thoſe two numbers; and becauſe you cannot find the ſquare in miles, therefore take it in leagues.

Leagues
848 $\frac{2}{3}$ the ſquare of it is, 720226.
Leagues
727, the ſquare of it is, 528529.

Add thoſe two ſquares together, and it is, as here you ſee, 1248755. The Root of this laſt number you may find

in

in the Table to be 1117 leagues, for the true diſtance betwixt the *Lyzard* and *Barbadoes*.

The Uſe of the Table of the Square Root in Navigation.

DIfference of Latitude and Departure given, I demand the diſtance ſailed.

A Ship having made 87 miles difference of Latitude, and departed 71 miles from the firſt Meridian, the diſtance Sail'd is deſired.

In the Table you will find theſe two numbers 87 and 71, and with the number you will find the Square of it, then add the two Squares together, and the total is the Square of the diſtance Sail'd, and in the Table you will find the laſt Square, and with it the root of it 112, which is the diſtance Sail'd; therefore I take it out of the Table, and ſet it down thus:

	Roots	Squares
Difference latit.	87	7569
Departure	71	5041
Diſtance ſailed	112 $\frac{66}{225}$	12610

Thus

Thus readily, and with eaſe, I find the diſtance Sail'd to be 112 miles.

Diſtance and Departure given, to find the difference of Latitude.

The diſtance Sailed 111 miles,
The Departure 57 miles,
What is the difference of Latitude?

In the Table you will find thoſe two Numbers or Roots 111 and 57, and with them you will find the ſquare of them, then ſubſtract the leſs ſquare from the greater, and the Remainer is the ſquare of the difference of Latitude, which Remainer or Square find in the Table, and with it you have the Root, which is the miles of difference of Latitude deſired; therefore I take it out of the Table, and ſet it down thus:

	Root	Squares
Diſtance Sailed	111	12321
Departure	57	3249
Difference Latit.	95 $\frac{47}{191}$	9072

Thus I readily find the difference of Latitude to be 95 miles.

Distance and Difference of Latitude given, to find the Departure.

The Distance sailed 356 miles,
Difference of Latitude 164 miles.

In the Table you will find those two Numbers or Roots, 356 and 164, and with them you will find the Squares of them, then substract the lesser Square from the greater Square, and the Remainer is the Square of the Departure, the Root whereof you will find in the Table to be 315 $\frac{615}{631}$ miles, so that it is very near one mile more, as you may see by the fraction. I say it is near 316 miles, and I take it out of the Table, and set it down thus:

	Roots	Squares
Distance sailed	356	126736
Difference Latit.	164	26896
Departure	315 $\frac{615}{631}$	99840

Thus I readily find the Departure to be 315 miles.

Course and Distance given to find the difference of Latitude, and the departure from the Meridian.

Course South-West.

LEt your distance run be long or short, take the square of it out of the Table, and divide that square by 2, and the Quotient is the square of your difference of Latitude, also the Quotient is the square of your departure from your first Meridian, the Root of which square find in the Table, and it is both your difference of Latitude, and also your departure from your first Meridian. Thus you have both difference of Latitude, and departure from your first Meridian, in one work.

Course and distance given to find the Difference of Latitude, and the departure from the first Meridian.

Course South-West and by South.

LET your distance run be long or short, take the Square of your distance out of the Table, and divide that square by 3 ¼ and the quotient is the Square of your departure from your first Meridian; then substract the quotient from the Square of your distance run, and the remainer is the Square of your difference of Latitude, and the root thereof you may find in the Table, and it is the difference of latitude.

Course and distance given to find the Difference of Latitude, and the departure from the first Meridian.

Course South South-West.

LET your distance run be long or short, take the Square of it out of the Table, and divide that Square of your distance run by 7, and the quotient

is the Square of your departure, the root of which Square is your departure, and you may ſoon find the root in the Table, for you have it with the Square; alſo ſubſtract the quotient from the Square of your diſtance run, and the remainer is the Square of your difference of Latitude, the root of which Square is adjoyning with it in the Table, and it is your difference of Latitude.

Courſe and diſtance given to find the Difference of Latitude, and the departure from the firſt Meridian.

Courſe South and by Weſt.

LET your diſtance run be long or ſhort, take the Square of it out of the Table, and divide the Square of your diſtance run by 25, and the quotient is the Square of your departure; the root of which Square found in the Table, is your deparrure from the Meridian; alſo ſubſtract the quotient from the Square of your diſtance run, and the remainer is the Square of your difference of Latitude; the root of which Square

is there with it in the Table, and it is your difference of Latitude.

Alſo obſerve, that as Courſe and Diſtance given, finds the difference of Latitude, and departure from the Meridian, by dividing the Square of the diſtance run, by certain numbers given for the diviſor to the Square of your diſtance run, upon ſuch and ſuch points of the Compaſs as your courſe is upon, and the Quotient of that diviſion is the Square of your departure: Alſo ſubſtract the Quotient from the Square of your diſtance run, and the Remainer is the Square of your difference of Latitude. Thus you have both departure and difference of Latitude in one work, and God willing, I ſhall give you the diviſor for every quarter point of the Compaſs; in the mean time, as by courſe and diſtance the departure and difference of Latitude is found, ſo by diſtance run, and departure, the courſe is found thus: Divide the Square of your diſtance run, by the Square of your departure, and the quotient will anſwer ſome of thoſe numbers before-mentioned, for ſuch and ſuch points of the Compaſs, and thus you readily have the

the Courſe. And as I have already ſhewed how by courſe and diſtance to find the difference of Latitude and Departure, for thoſe four points of the Compaſs, from South to South-Weſt, ſo alſo the very ſame order is to be kept from South-Weſt to Weſt: for divide every point by the ſame numbers, only now the Quotient will be the ſquare of the difference of Latitude, and the Remainer of the Subſtraction will be the Square of the Departure; alſo what is here ſaid of this quarter of the Compaſs, for finding the difference of Latitude, and Departure from the Meridian, the like is to be done by the other three quarters of the Compaſs, for as the former directions are for thoſe ſeven points of the Compaſs betwixt South and Weſt, the very ſame order and rule is to be kept betwixt South and Eaſt, alſo betwixt North and Weſt, and betwixt North and Eaſt: So that the rule obſerved for the firſt four points, ſerves alſo for the other 28 points, and ſo for all the 32 points of the Compaſs, and being that your Courſe may ſometime be upon a point and an half, as South-Weſt, and

one half Southerly, or other ſuch like, I ſhall therefore, God willing, direct you to the difference of Latitude, and Departure from the Meridian, for every quarter point of the Compaſs, for which purpoſe I have made a Table.

Here followeth a Table of the Diviſors, or of the ſeveral numbers, by which to divide the Square of the diſtance run upon any point of the Compaſs, thereby to find the difference of Latitude, and the departure from the Meridian. In this Table I have omitted ſome fractions, for evenneſs of number, and for eaſe and readineſs in the work, conſidering that many men may make uſe of the Table that underſtand not broken numbers.

And theſe four numbers 25 7 3 $\frac{1}{4}$ 2, which in the Table are ſet to the firſt four points of the Compaſs, will ſerve for all the 32 points, for as 25 is the number by which to divide the ſquare of your diſtance run, when you Sail South and by Weſt, ſo alſo 25 is the number or diviſor to the Square of your diſtance run, when you Sail Weſt and by South, only as before the Quotient was your

your Departure, and the remainer of the Subſtraction was your difference of Latitude, now it is the contrary, for the Quotient is the difference of Latitude, and the remainer of the Subſtraction is the Departure from the Meridian.

The Compaſs Table.

Points of the Compaſs	Courſe	Diviſor
1	South and by Weſt	25
2	South South-Weſt	7
3	South-Weſt and by South	3 ¼
4	South-Weſt	2

Again, 7 is the diviſor when you Sail S. S. Weſt; alſo 7 is the diviſor when you Sail W. S. W. this may ſerve for all the 32 points of the Compaſs. I have alſo on the next Leaf made a Table for every quarter point of the Compaſs.

Point

The Compaſs Table.

Point	Courſe	Diviſor
0 $\frac{1}{4}$	South $\frac{1}{4}$ Weſt.	400
0 $\frac{1}{2}$	South $\frac{1}{2}$ Weſt.	100
0 $\frac{3}{4}$	South $\frac{3}{4}$ Weſt.	44 $\frac{1}{2}$
1 0	South and by Weſt.	25
1 $\frac{1}{4}$	S. by W. $\frac{1}{4}$ Weſt.	19
1 $\frac{1}{2}$	S. by W. $\frac{1}{2}$ Weſt.	12 $\frac{3}{4}$
1 $\frac{3}{4}$	S. by W. $\frac{3}{4}$ Weſt.	9 $\frac{1}{5}$
2 0	South South-Weſt.	7 0
2 $\frac{1}{4}$	S. S. W. $\frac{1}{4}$ Weſt.	6 0
2 $\frac{1}{2}$	S. S. W. $\frac{1}{2}$ Weſt.	5 0
2 $\frac{3}{4}$	S. S. W. $\frac{3}{4}$ Weſt.	4 0
3 0	South Weſt and by South	3 $\frac{1}{4}$
3 $\frac{1}{4}$	S. W. by S. $\frac{1}{4}$ Weſt.	3 0
3 $\frac{1}{2}$	S. W. by S. $\frac{1}{2}$ Weſt.	2 $\frac{7}{8}$
3 $\frac{3}{4}$	S. W. by S. $\frac{3}{4}$ Weſt.	2 $\frac{3}{8}$
4 0	South-Weſt.	2 0

Course and distance given to find the departure from the Meridian, and difference of Latitude.

COurse South South-West 50 Leagues, I demand the Departure and the difference of Latitude.

According to my former directions, this course being S. S. W. my divisor for the distance run upon that point of the Compass is 7; and in the Table I find the Square of 50 to be 2500, which I divide by 7, and the Quotient is 357 for the Square of my departure, and the Table shews me the Root of it to be 18; then I substract the Quotient from the Square of the distance run, and the Remainer is 2143: the Root of which Remainer being 46 is my difference of Latitude. Thus I find my departure to be 18 Leagues, and my difference of latitude to be 46 Leagues.

7 (1
25 00
7 7 7

Square 357 Root 18

2500
357
2143 Square

Now if my Course had been W. S. W. then 46 had been my departure, and 18 had been my difference of Latitude.

Depar-

A Scale of 108 Leagues, being 3 Leagues betwixt prick and prick.

12 24 36 48 60 72 84 96 108

Having

Having ſailed Weſt South-Weſt 47 leagues, I demand the difference of Latitude, and departure from the Meridian.

I find in the Table the ſquare of 47 to be 2209, which I divide by 7, and the Quotient is

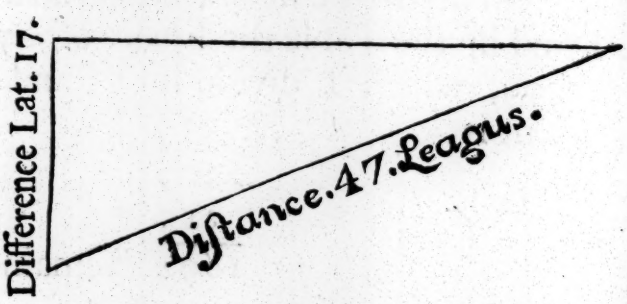
$$\begin{array}{r|l} 13 & 4 \\ 22 & 89 \\ 7 & 7 \end{array} \quad \begin{array}{l} 315 \\ \hline 2209 \\ 315 \\ \hline 1894 \text{ Remainer} \end{array}$$

Then I ſubſtract the Quotient from the ſquare of my diſtance ſailed, and the Remainer is the ſquare of my departure; and my courſe being more than four points from the Meridian, therefore the Quotient is the ſquare of difference of Latitude, and the remainer of the ſubſtraction is the ſquare of my departure from the Meridian. The Root of thoſe two ſquares is the difference of Latitude and Departure; and in the Table I find the Roots to be

Diffe-

A Scale of 108 Leagues, being 3 Leagues betwixt prick

Difference Latitude 17 Leagues.
Departure 43 Leagues.



Having ſailed Weſt and by South 56 leagues, what is my Difference Latitude and Departure from my firſt Meridian.

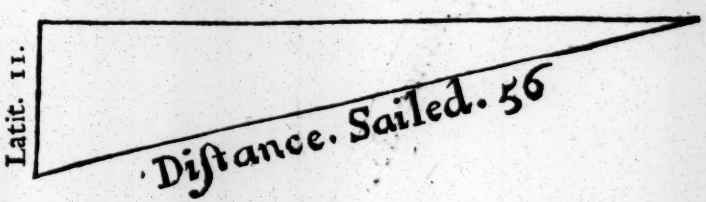
I find in the Table the ſquare of 56 to be 3136, and my diviſor for this courſe Weſt and by South, is 25, therefore I divide the Square of my diſtance by 25, and the Quotient is the Square of my difference of Latitude; alſo I ſubſtract the Quotient from the ſquare of my diſtance ſailed, and the Remainer is the ſquare of my departure from the Meridian.

1				3136	
25				125	Root
561		Root		3011	55
3136	125	11			
1111					
25					

And

And I find in the Table the Roots of those two numbers to be 11 and 55.

Difference Latitude 11 Leagues.
Departure 55 Leagues.



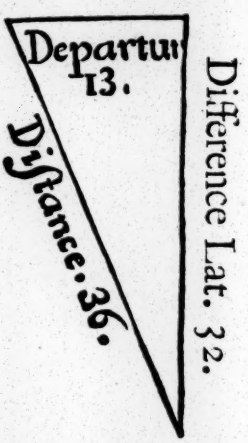
Sailing Nor. Nor. West 36 miles, what is my departure, and difference of Latitude?

In the Table I find the square of 36 to be 1296, and my divisor for that point of the Compass is 7, therefore I divide the square of my distance run by 7.

55 (1		Root	1296		
25	185	13	185	Root	
777			1111	32	

and my course being but two points from the Meridian, therefore the Quotient is the Square of my departure, and the remainer

mainer of the Subſtraction is the Square of the difference of Latitude.



Sailing Weſt Nor. Weſt 36 Miles, what is my departure and difference of Latitude?

In the Table you will find the Square of 36 to be 1296, and the diviſor for that point 7.

53 (1		Root	1296 185	Root
1298	185	13	1111	32
777				

and my courſe being more than 4 Points from the Meridian, therefore my Quotient the Root of it 13, is my difference

ference Latitude and the remainer of the Subſtraction, the Root of it is my departure, being 32.

Difference Latitude 13.
Departure 32.

Having Sailed Nor. Eaſt and by Nor. 120 Leagues, what is my departure and difference of Latitude?

In the Table I find the Square of 120 to be 14400; and in the Compaſs Table I find the diviſor for that point to be 3 ¼, by which I divide the Square of the diſtance, and the Quotient is 4430, and in the Table I find the Root of it to be 66 Leagues for my departure; then I ſubſtract the Quotient from the Square of the diſtance, and the Remainer 9970 is the Square of my difference of Latitude, and in the Table I find the Root

of it to be 100 Leagues for the difference of Latitude.

Departure 66 Leagues.
Difference Latitude 100 Leagues.

57600
13 44400
4 1
13

**(1
****(0
*7600 (4430
*3333
***
Subſtraction
14400
4430
9970

Having Sailed Nor. Eaſt and by Eaſt 120 Leagues, what is my difference of Latitude and departure?

In the Table I find the ſquare of 120 to be 14400, and the diviſor 3 $\frac{1}{4}$, by which I divide the ſquare of the diſtance, and the Quotient is 4430; and in the Table I find the root of it to be 66 Leagues, my difference of Latitude; then I ſubſtract the Quotient from the

ſquare

quare of the diſtance run, and the remainer is 9970, and in the Table I find the root of it to be 100 Leagues for my departure from the Meridian.

Difference of Latitude 66 Leagues.
Departure from Meridian 100 Leagues.

Here you ſee my courſe is more than 4 points from the Meridian, therefore the root of the Quotient is the difference of Latitude, and the root of the remainer of the ſubſtraction is the departure from the Meridian; but if the courſe had been leſs than 4 Points from the Meridian, then the root of the Quotient had been departure, and the root of the remainer of the Subſtraction had been difference of Latitude; and if the courſe be juſt 4 Points from the Meridian, as N. E. or N. W. S. E. or S. W. then the root of the Quotient is both difference of Latitude, and departure from the Meridian.

To find the Courſe by the Table of the Square Root.

DIſtance and departure given to find the Courſe.

Having Sailed South Weſterly 50 Lea. and being departed from my firſt Meridian 18 Leagues, what is my courſe?

Divide the ſquare of your diſtance run by the ſquare of your departure, and the Quotient will anſwer ſome of thoſe numbers, which are ſet down for diviſors to the Points of the Compaſs in the Compaſs Table, as in this queſtion: The diſtance ſailed 50 Leagues, in the Table I find the ſquare of it to be 2500, and the departure from the Meridian 18 Leagues, in the Table I find the ſquare of it to be 324, by which I divide the ſquare of the diſtance and the Quotient is 7, which anſwers to the diviſor, for S. S. Weſt, as you may ſee in the Table, for the points of the Compaſs, which I call the Compaſs Table.

23
462
2500 (7
324

Thus

Thus I find my courſe to be South South-Weſt.

Having ſailed South Weſterly 50 Leagues and altered my Latitude 18 Leagues, upon what Point have I ſailed?

In the Table I find the ſquare of 50 to be 2500, alſo I find the ſquare of 18 to be 324, by which I divide the ſquare of the diſtance, and the Quotient is 7, which anſwers to W. S. Weſt.

23
462
2500 (7
324

Thus I find the courſe to be W. S. W.

Now obſerve that if diſtance and difference of Latitude be given to find the courſe, then find the departure alſo, and if the departure exceed the difference of Latitude; then work as I have here done above by difference of Latitude; but if the depature be leſs than the difference of Latitude, then work by it, for you muſt al-

ways to find the courſe, work or divide the ſquare of your diſtance by the leſſer ſquare of the two, that is, by the leſſer ſquare of the difference of Latitude and departure: and if the difference of Latitude be the leſs, then the courſe is more than 4 Points from the Meridian, but if the departure be leſs, then the courſe is leſs than 4 Points from the Meridian; alſo the diviſor will be leſs than half the ſquare of your diſtance, and the other will be more than half, for if the two ſquares be equal, then they two added together, make juſt the ſquare of the diſtance, and then the courſe is juſt 4 Points from the Meridian, that is South-Weſt, or North-Weſt, South-Eaſt, or North-Eaſt, this may ſerve for directions.

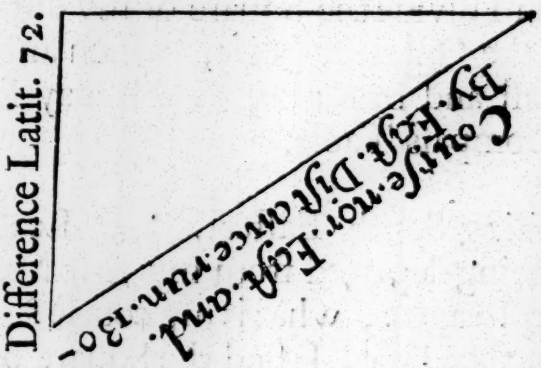
Having ſailed Nor. Weſterly 264, and departed from my firſt Meridian 186, upon what Point of the Compaſs hath my courſe been? In the Table I find the ſquare of 264 to be 69696; alſo in the Table I find the ſquare of 186 to be 34596, by which I divide the ſquare of my diſtance, and the Quotient is 2, which

which anſwers to the diviſor N. W. as you may ſee in the Compaſs Table.

Thus I find my courſe to be Nor. Weſt.

Having ſailed Nor. Eaſterly 130 leagues, and having changed my Latitude 72 leagues, what is my courſe?

In the Table I find the ſquare of 130 to be 16900, and the ſquare of 72 to be 5184, by which I divide the ſquare of my diſtance ſailed, and the Quotient is $3\frac{13}{51}\frac{52}{84}$, which fraction makes $\frac{1}{4}$, which anſwers Nor. Eaſt and by Eaſt, as you may ſee by the Compaſs Table.



Having Sailed South Eaſterly 130 miles, and departed from my firſt Meridian 26 miles, what is my courſe?

In the Table I find the Square of my diſtance to be 16900, and the Square of my departure to be 676, by which I divide the Square of my diſtance, and the Quotient is 25, which anſwers to S. by Eaſt, as you may ſee in the Compaſs Table.

Having Sailed S. Eaſterly 130 miles, and changed my Latitude 26 miles, what is my courſe?

In the Table I find the Square of my diſtance to be 16900; and the Square of my difference of Latitude to be 676, by which I divide the Square of my diſtance, and the Quotient is 25, which anſwers to Eaſt and by South, as you may ſee in the Compaſs Table.

Sailing South Eaſterly 300 Leagues, and being departed from my firſt Meridian 30 Leagues, what is my courſe?

In the Table I find the Square of my diſtance to be 90000, and the Square of my departure to be 900 Leagues, by which

which I divide the Square of my diſtance, and the Quotient is 100, which anſwers to South and one half Eaſt, as you may ſee in the Compaſs Table for the quarter points of the Compaſs.

Sailing South Eaſterly 300 Leagues, and having changed my Latitude 15 Leagues, what is my courſe?

In the Table I find the ſquare of my diſtance to be 90000, and the ſquare of my difference of Latitude to be 225; by which I divide the ſquare of my diſtance, and the Quotient is 400, which anſwers to Eaſt and one fourth South, as you may ſee in the Table for the quarter points of the Compaſs.

I find my Courſe to be Eaſt and ¼ South.

Having Sailed South Weſterly 300 Leagues, and being departed from the Meridian 150 Leagues, what is my courſe?

In

In the Table I find the ſquare of the diſtance to be 90000, and the ſquare of my departure to be 22500, by which I divide the ſquare of diſtance, and the Quotient is 4, which anſwers to S. S. W. and ¾ Weſt, as you may ſee in the Table for the quarter points of the Compaſs.

12
90000 (4
22500

Sailing South Weſterly 300 Leagues, and having changed my Latitude 150 Leagues, what is my courſe?

In the Table I find the Square of my diſtance to be 90000, and the Square of difference of Latitude 22500, by which I divide the Square of diſtance, and the Quotient is 4, which anſwers to Weſt South-Weſt, and ¾ South, as you may ſee in the Table for the quarter points of the Compaſs.

By Courſe and departure, to find the diſtance and difference of Latitude.

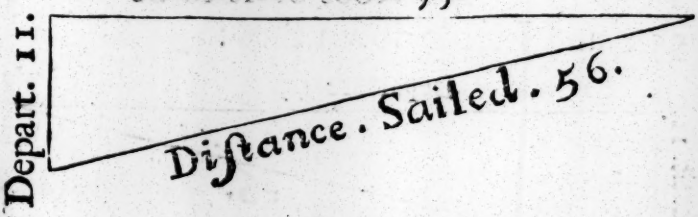
Sailing South and by Weſt, and being departed from my firſt Meridian 11 leagues,

eagues, what is my diſtance and diffe-ence of Latitude?

In the Table you will find the ſquare of 11 to be 121, and the Compaſs Table ſhews 25 for that point of the Compaſs, by which multiply the ſquare of the departure, and the product being 3025, is the ſquare of your diſtance; from which ſubſtract the ſquare of departure, and the remainer is the ſquare of your difference of Latitude, and the Table ſhews you the Roots of thoſe two numbers to be 56 and 55; and I ſet it down thus;

121	
25	
605	
242	
3025	
3025	
121	
2904	

The diſtance Sailed 56 leagues.
The difference of latitude 55 leagues.

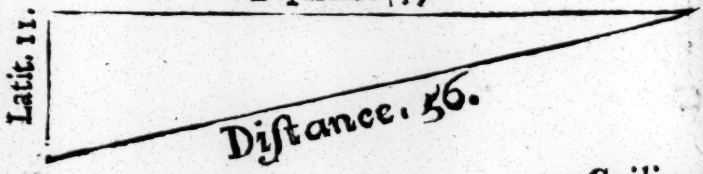


By Course and Difference of Latitude find the distance and departure.

Sailing West and by South, and having changed my Latitude eleven miles what is my Distance and Departure?

The Table shews you the square of 11 to be 121, and the Compass Table shews you the number for that point of the Compass to be 25, by which I multiply the square of my difference of latitude and the product is 3025, for the square of my distance, and in the Table I find the Root of it to be 56 for the distance; then from the square of the distance I substract the square of difference of Latitude, and the Remainer 2904 is the square of the departure from the first Meridian, and the Table shews the Root of it to be 55; and I set it down thus:

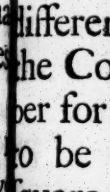
121	
25	
605	
242	
3025	
3025	
121	
2904	



Sailing

Sailing South and by West, until my difference of latitude be 55 leagues, what is my distance and departure?

In the Table I find the square of the difference of latitude to be 3025, and the Compass Table shews me the number for that point of the Compass S. by W. to be 25, by which I must divide the square of the difference of latitude, and the Quotient is 121 for the square of my departure from the Meridian; then add the square of difference of latitude, and the square of departure together, and the total 3146 is the square of your distance, and the Table shews me the Root of those two squares to be 56 and 11; and I set it down thus:



Distance 56 leagues.
Departure 11 leagues.

Observe that departure is reckon'd from the Meridian, either Eastward or Westward, and latitude is reckon'd from the Equinoctial either Northward or Southward

Also

Alſo obſerve if miles or leagues of dif
rence of latitude and Courſe be given
find the diſtance and departure, then
your courſe be leſs than four points fro
the Equinoctial, then you muſt multip
the ſquare of your difference of latitu
by the number for that point of the Co
paſs, as it is ſet down in the Compaſs T
ble; as ſuppoſe your courſe to be We
and by South, which is but one poi
from the Equinoctial, then the ſqua
of your difference of latitude muſt
multiplied by 25, and the product is t
Square of your Departure; but if yo
courſe be more than 4 points from the
quinoctial, as South and by Weſt, whi
is ſeven points from the Equinoctial, th
the ſquare of the difference of latitu
muſt be divided by 25, and the Quotie
will be the ſquare of the departure
which two ſquares of latitude and depa
ture being added together, make th
ſquare of the diſtance.

Again if miles or leagues of departu
from the Meridian, and the courſe be g
ven to find the diſtance, and the diff
rence of latitude; then if your courſe b
le

leſs than 4 points from the Meridian, then you muſt multiply the ſquare of your departure by the number for that point of the Compaſs, as it is ſet down in the Compaſs Table; as ſuppoſe your courſe to be South and by Weſt, which is but one point from the Meridian, therefore the ſquare of your departure muſt be multiplied by 25, and the product is the ſquare of difference of latitude, which two ſquares added together, make the ſquare of the diſtance.

But if your courſe be Weſt and by South, that is 7 points from the Meridian, then the ſquare of your departure muſt be divided by 25, and the Quotient will be the ſquare of your difference of latitude; which two ſquares of departure and difference of latitude being added together, make the ſquare of your diſtance.

Here followeth a uſeful Table of the Cube Root, where you may readily, and with eaſe, find the Cube Root of any number from 8 to 9261000. This Table is very plain and eaſie, every leaf ſide being divided into three Columns or Spaces; in the firſt is ſet down the Cube num-

number, in the ſecond is ſet down the Cube Root of that number, and in the third is ſet down the true Denominator to the Remainer of all the numbers from that right Cube number to the next right Cube number, and with an eaſie Subſtraction, taking but the next Cube number (that is leſs than the given number) from your given number, and ſo you have the Remainer belonging to the Root of that given number: Example; Let the given number be 4504, and you would know the Cube Root of it, and it is not in the Table, being not a right Cube number; but the Root of it and the Denominator is in the Table; and do but ſubſtract the next right Cube number in the Table that is leſs than it, from it, being 4096, and there remains 408; thus you have

Number	Root	Remainer
4504	16	$\frac{408}{817}$

Cube

Cube	Root	Denominat.
0008	02	019
0027	03	037
0064	04	061
0125	05	091
0216	06	127
0343	07	169
0512	08	217
0729	09	271
1000	10	331
1331	11	397
1728	12	469
2197	13	547
2744	14	631
3375	15	721
4096	16	817
4913	17	919

Cube	Root	Denominat.
5832	18	1027
6859	19	1141
8000	20	1261
9261	21	1387
10648	22	1519
12167	23	1657
13824	24	1801
15625	25	1951
17576	26	2107
19683	27	2269
21952	28	2437
24389	29	2611
27000	30	2791
29791	31	2979
32778	32	3169
35937	33	3367

Cube	Root	Denominat.
39304	34	3571
42875	35	3781
46656	36	3997
50653	37	4219
54872	38	4447
59319	39	4681
64000	40	4921
68921	41	5167
74088	42	5419
79507	43	5677
85184	44	5941
91125	45	6211
97336	46	6487
103823	47	6769
110592	48	7057
117649	49	7351

Cube	Root.	Denominat.
125000	50	7651
132651	51	7957
140608	52	8269
148877	53	8587
157464	54	8911
166375	55	9241
175616	56	9577
185193	57	9919
195112	58	10267
205379	59	10621
216000	60	10981
226981	61	11347
238328	62	11719
250047	63	12097
262144	64	12481
274625	65	12871

Cube	Root	Denominat.
287496	66	13267
300763	67	13669
314432	68	14077
328509	69	14491
343000	70	14911
357911	71	15337
373248	72	15769
389017	73	16207
405224	74	16651
421875	75	17101
438976	76	17557
456533	77	18019
474552	78	18487
493039	79	18961
512000	80	19441
531441	81	19927

Cube	Root	Denominat.
551368	82	20419
571787	83	20917
592704	84	21421
614125	85	21931
636056	86	22447
658503	87	22969
681472	88	23497
704969	89	24031
729000	90	24571
753571	91	25117
778688	92	25669
804357	93	26227
830584	94	26791
857375	95	27361
884736	96	27937
912673	97	28519

Cube	Root	Denominat.
941492	98	29107
970299	99	29701
1000000	100	30301
1030301	101	30907
1061208	102	31519
1092727	103	32137
1124864	104	32761
1157625	105	33391
1191016	106	34027
1225043	107	34669
1259712	108	35317
1295029	109	35971
1331000	110	36631
1367631	111	37297
1404928	112	37969
1442897	113	38647

Cube	Root	Denominat.
1481544	114	39331
1520875	115	40021
1560896	116	40717
1601613	117	41419
1643032	118	42127
1685159	119	42841
1728000	120	43561
1771561	121	44287
1815848	122	45019
1860867	123	45757
1906624	124	46501
1953125	125	47251
2000376	126	48007
2048383	127	48769
2097152	128	49537
2146689	129	50311

Cube	Root	Denominat.
2197000	130	51091
2248091	131	51877
2299968	132	52669
2352637	133	53467
2406104	134	54271
2460375	135	55081
2515456	136	55897
2571353	137	56719
2628072	138	57547
2685619	139	58381
2744000	140	59221
2803221	141	60067
2863288	142	60919
2924207	143	61777
2985984	144	62641
3048625	145	63511

Cube	Root	Denominat.
3112136	146	64387
3176523	147	65269
3241792	148	66157
3307949	149	67051
3375000	150	67951
3442951	151	68857
3511808	152	69769
3581577	153	70687
3652264	154	71611
3723875	155	72541
3796416	156	73477
3869893	157	74419
3944312	158	75367
4019679	159	76321
4096000	160	77281
4173281	161	78247

Cube	Root	Denominat.
4251528	162	79219
4330747	163	80197
4410944	164	81181
4492125	165	82171
4574296	166	83167
4657463	167	84169
4741632	168	85177
4826809	169	86191
4913000	170	87211
5000211	171	88237
5088448	172	89269
5177717	173	90307
5268024	174	91351
5359375	175	92401
5451776	176	93457
5545233	177	94519

Cube	Root	Denominat.
5639752	178	95587
5735339	179	96661
5832000	180	97741
5929741	181	98827
6028568	182	99919
6128487	183	101017
6229304	184	102121
6331625	185	103231
6434856	186	104347
6539203	187	105469
6644672	188	106597
6751269	189	107731
6859000	190	108871
6967871	191	110017
7077888	192	111169
7189057	193	112327

Cube	Root	Denominat.
7301384	194	113491
7414875	195	114661
7529536	196	115837
7645373	197	117019
7762392	198	118207
7880599	199	119401
8000000	200	120601
8120601	201	121807
8242408	202	123019
8365427	203	124237
8489664	204	125461
8615125	205	126691
8741816	206	127927
8869743	207	129169
8998912	208	130417
9129329	209	131671
9261000	210	132931

I ſhall here ſhew you an eaſie and a ready way to find the Cube Root of any number to 9261000, with the true value of the Remainer.

Let 216 be a given number, and you would know the Cubick Root of it, in the Cubick Table find the Cube number 216, and in the next Column towards the right hand you will find the Root of it to be 6, therefore 6 is the Cube Root of 216, thus readily you have the Root of it; and I ſet it down thus:

Number	Root
216	6

Alſo I find it to be a right Cube number, produced of the multiplication of 6, in it ſelf, and that product multiplied again by 6. If the given number be not a right Cube number, then there will be a Remainer to the Root, and all the numbers from this 216 to 343 are not right Cube numbers, for there will be a remainer to the Root of every one of them, and there are 126 of them numbers that are not right Cube numbers before you come

come to the next right Cube number, which is 343. Now I ſhall ſhew you the true value of the Remainer of the Root of all thoſe numbers. And here obſerve that 6 is the Cube Root of 216; alſo 6, with ſome Remainer, is the common Root to all thoſe 126 numbers that are not right Cube numbers, until you come to 343, which is the next right Cube number; and, as I have ſaid, 6 is the common Root to them all, with ſome remainer, ſo 127 is the common denominator to them all, to the remainer of them all; for as the number increaſes the remainer increaſes, but the Root and alſo the Denominator is ſtill the ſame, and common to them all, till you come to the next right Cube number, and then the Root is juſt one unite more, that is 7, and no remainer.

Then again, 7 is the Root of 343, alſo 7 is the Cube Root, with ſome Remainer, of all thoſe numbers betwixt 343 and 512, which is the next right Cube number, and 169 is the common Denominator to them all, to the Remainer of them all; thus in the Table you may readily

readily find any right Cube number, and the Root of it, and the Denominator to the remainer: And for to find the Remainer, if the given number be not a right Cube, then look in the Table for the right Cube number that is leſs than your given number, and ſubſtract it from the given number, and the Remainer of that Subſtraction is the Remainer to the Root of that given number, and the Table ſhews you the Denominator; thus you may readily have the Root and Remainer, and Denominator, to any number. Example: I would know the Cube Root of 222, and it is not in the Table, therefore it is no right Cube, then I take the right Cube in the Table, which is leſs than it, being 216, which I ſubſtract from the given number 222, and there remains 6. Here this little Subſtraction gives you the Remainer, and the Table gives you the Root and the Denominator; and I ſet it down thus:

222
216
6

Number	Root	Remainer
222	6	$\frac{6}{127}$

Which

Which fraction makes $\frac{1}{217}$ very near, for abate but one from the Denominator, make it but 126, and then it may be abbrevied to $\frac{1}{21}$.

Again, I would know the Cube Root of 321, now I cannot find this number in the Table, therefore I take the number in the Table that is leſs than it, and ſubſtract it from this given number, and there remains 105, which is the Remainer to the Root of this given number 321, and the Table gives you the Root and the Denominator; therefore I ſet it down thus:

321
216
105

Number	Root	Remainer
321	6	$\frac{105}{127}$

Now abate but one from the Denominator, make it $\frac{105}{126}$, and then it may be abbrevied to $\frac{5}{6}$, then the Root would be $6\frac{5}{6}$, therefore you ſee it is very little leſs, but the juſt Root is $6\frac{105}{127}$.

Thus any Number whereof you deſire the Cube Root, you may readily take it out of the Table, both the Root and

Denominator, and an eaſie ſubſtraction gives you the Remainer.

Thus the extracting of the Cube Root, which formerly was tedious, and difficult to work; ſo tedious that one queſtion took much time, and ſo difficult that the true value could not be found; for which reaſon this excellent, neceſſary, and uſeful Rule was much laid aſide; but thoſe wants being now made up, the Rule is now eaſie and plain, and rather a delight and recreation, than any toyl or labour, to work.

Therefore, for Recreation, I deſire to know the Cube Root of 778688; in the Table I find the Number, and with it the Root 92, and being a right Cube number, there is no Remainer; and I ſet it down thus:

Number	Root
778688	92

Again, what is the Root of 1259712? Being a right Cube number, I find it in the Table, and the Root with it, and I ſet it down thus;

Num-

Number	Root
1259712	108

Again, what is the Root of 8489664? Being a right Cube number, I find it in the Table, and the Root with it, 204.

Number	Root
8489664	204

Alſo, if you deſire the Root of any number that is not a right Cube, you have little more labour with it, for in the Table take the next number to it, and leſs than it, and ſubſtract it from your given number, and this Subſtraction is all the labour that you have with this more than you had with the other, that was a right Cube number. What is the Root of 781540?

778688

002852 Remains.

Number	Root	Remainer
781540	92	$\frac{2852}{2560}$

Which fraction makes $\frac{1}{9}$ near.

Again, I would know the Cube Root of 801504
778688
22816

Number.	Root	Remainer
801504	92	$\frac{22816}{25669}$

Which fraction makes $\frac{8}{9}$ near.

You ſee how uſeful and eaſie it is to anſwer this Queſtion laſt ſet down, to find the Root of it, and the true value of the Remainer, and being abbrevied makes $\frac{8}{9}$ of one whole, whether Inches or Feet, or Yards or Miles, or any other Meaſure, and now the fraction being underſtood, the true value of it being known, and alſo abbrevied to $\frac{8}{9}$, it may now be taken off the Scale with the Compaſs, and added to the Root: It is ſomething leſs than $\frac{8}{9}$, for if the Queſtion were inches, then divide one inch into 25669 parts, and it is but one of thoſe parts leſs than $\frac{8}{9}$. Thus the true value of the Remainer being known, makes the rule delightſome and uſeful.

What

What is the Cube Root of 8552394? According to my former directions, the right Cube that is leſs than it, I Subſtract from it, and I ſet it down thus:

Number	Root	Remainer
8552394	204	$\frac{62730}{135461}$

Which fraction makes $\frac{1}{2}$ to be added to the Root, ſo it is 204 $\frac{1}{2}$. How readily this Queſtion is anſwered.

The Uſe of the Cube Root for Shipwrights.

A Ship of 100 Tuns was found to be by meaſure 44 Foot long by the Keel, 20 Foot broad upon the Midſhip Beam, 9 Foot deep in the Hold, and did rack it with the Stem forwards, 13 Foot, and the Stern-poſt did rack offwards, 7 Foot; and you would make another Ship of the ſame Mold, whoſe burden ſhould be double to it, that is 200 Tuns.

Firſt, for the Keel 44 Foot long, in the Table you will find the Cube of it to be 85184, which number muſt be dou-

bled, becauſe the Ship is to be double the burden of the other Ship, and it makes 170368, and the Table ſhews you the Cube Root of it to be 55 Foot $\frac{3}{9}\frac{9}{2}\frac{3}{4}\frac{3}{1}$, which fraction makes 5 inches and $\frac{1}{8}$ part of an inch, and a little more, yet it will not reach to $\frac{1}{5}$ part of an inch. Here I find the length of the Keel muſt be 55 foot, 5 inches, and $\frac{1}{5}$ part of an inch.

85184	
	2
170368	

Then for the breadth at the Midſhip Beam 20 foot, in the Table you will find the Cube of it to be 8000, which doubled makes 16000, and the Table ſhews you the Cube Root of it to be 25 foot; and $\frac{3}{7}\frac{7}{3}\frac{5}{7}$ parts, which fraction makes 2 inches and one third part of an inch, to be added to the Root: Thus I find the breadth at the Beam muſt be

8000	
	2
16000	

Foot	Inch	Part
25	2	$\frac{1}{3}$ of an Inch.

Then the depth in Hold 9 foot, in the Table you will find the Cube of it to be 729,

729, which being doubled, makes 1458, and the Table ſhews you the Cube Root of it to be 11 foot, $\frac{127}{397}$ parts of a foot, which fraction makes 3 inches and $\frac{1}{8}$ parts of an inch to be added to the Root; Thus I find the depth in Hold muſt be

729
2
1458

Foot	Inch	Part
11	3	$\frac{1}{8}$ of an Inch.

Near 4 Inches.

Then for the Rack forwards 13 foot, in the Table you will find the Cube of it to be 2197, which being doubled, makes 4394, and the Table ſhews you the Cube Root of it to be 16 foot, $\frac{398}{817}$ parts of a foot, which fraction makes 4 inches and $\frac{1}{2}$ part of an inch, to be added to the Root: Thus I find the Rack forward to be

2197
2
4394

Foot	Inch	Part
16	4	$\frac{1}{2}$ of an Inch.

The n for the Rack offwards 7 foot, in the Table you will find the Cube of it to be 343, which being doubled makes 686, and the Table ſhews you the Cube Root of it to be 8 foot, and $\frac{174}{217}$ parts of a foot, which fraction makes 9 inches and $\frac{1}{2}$, for the Rack offwards.

343
2
686

Foot	Inch	Part
8	9	$\frac{1}{2}$ of an Inch.

Thus you readily have the Meaſures deſired for a Ship of 200 Tun burden.

Another will have a Ship built of 500 Tun burden, and he will have her of the ſame mold with the firſt Ship of 100 Tun, becauſe the firſt Ship was found to have many good qualities, being a good Sailer, and Seas kindly.

The meaſures of the firſt Ship was, the length of the Keel 44 foot, the breadth at Midſhip Beam 20 foot, deep in the Hold 9 foot, Rack forward with the Stem 13 foot, Rack offward with Stern-poſt 7 foot.

Firſt, for the length of the Keel 44 foot, in the Table you will find the Cube of it 85184, which number muſt be multiplied by 5, becauſe this Ship muſt be five times the burden of the firſt Ship, and the product is 425920, and in the Cube Table I find the Cube Root of it to be 75 foot, $\frac{4}{17}\frac{0}{1}\frac{4}{6}\frac{5}{1}$ parts of a foot, which fraction makes 2 inches and $\frac{1}{3}$ of an inch: Thus I find the length of the Keel to be 75 foot, and near 3 inches.

	85184
	5
	425920

Foot	Inch
75	3 near.

For the breadth at Midſhip Beam 20 foot, in the Cube Table you will find the Cube of it to be 8000, which multiplied by 5, makes 40000; and in the Table I find the Cube Root of it to be 34 foot, $\frac{6}{3}\frac{9}{5}\frac{4}{7}\frac{}{1}$ parts of a foot, which fraction makes 2 inches and $\frac{1}{3}$ part of an inch.

	8000
	5
	40000

Foot

Foot	Inch	Part
34	2	$\frac{1}{3}$ of an Inch.

For the depth in Hold 9 foot, in the Table you will find the Cube of it to be 729, which multiplied by 5, produceth 3645; and the Cube Table ſhews the Cube Root of it to be 15 foot, and $\frac{270}{721}$ parts of a foot, which fraction makes 4 inches and $\frac{1}{3}$; thus I find the depth in Hold to be

729
5
3645
1

Foot	Inch	Part
15	4	$\frac{1}{2}$ of an Inch.

For Rack forward with the Stem 13 foot; in the Cube Table I find the Cube of it to be 2197, which I multiply by 5, and it bringeth forth 10985, and the Table ſhews the Root of it to be 22 foot, and $\frac{337}{1519}$ parts of a foot, which fraction makes 2 inches, and $\frac{2}{3}$ parts of an inch.

2197
5
10985

Foot	Inch	Part
22	2	$\frac{2}{3}$ of an Inch.

For the Rack of Stern-Poſt offward 7 foot, in the Cube Table you will find the Cube of 7 to be 343, which muſt be multiplied by 5, and the product is 1715, and in the Table I find the Cube Root of it to be 11 foot, $\frac{384}{397}$ parts of a foot, which fraction makes 11 inches and $\frac{2}{3}$ parts of an inch, that is near one foot to be added to the Root.

Foot	Inch	Part
12 very near	00	00

Length of the Keel 75 foot and 3 inches.

Breadth 34 foot, 2 inches, $\frac{1}{3}$ of one inch.

Depth 15 foot, 4 inches, and $\frac{1}{3}$.

Rack at Stem 22 foot, 2 inches, and $\frac{2}{3}$.

Rack at Stern 12 foot.

Thus you have the meaſures of a Ship of 500 Tun burden.

A Queſtion of a Granado ſhell by the Cube Table.

A Granado ſhell being 14 inches in Diameter, and 2 ½ inches ſubſtance of metal, what is the weight of the metal, and content, in Cubical ſquare inches?

In the Cube Table you will find the Cube of 14 the Diameter to be 2744, which multiplied by eleven, amounts to 30184, which divide by 21, and the Quotient gives the ſolid inches in the whole, as if it were a ſolid Bullet: As here I find in the Quotient 1437 inches and ⅓ part of an inch.

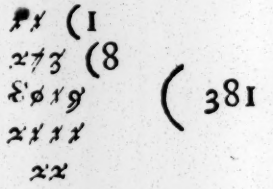
2744	
11	
2744	
2744	
30184	

xxx
x97x (7
3ox8x (1437 ⅓
xxxxx
xxx

Then

Then from the diameter 14 inches, take the diameter of the thickneſs of the metal, being 5 inches, and there remains 9 inches, and in the Cube Table you will find the Cube of 9 to be 729, which multiply by 11, and it amounts to 8019, which divide by 21, and the Quotient gives the inches contained in the hollow part of the Granado.

729
11
729
729
8019



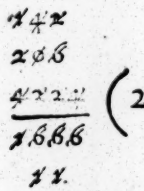
Here I find by the Quotient that the hollow part of the Granado contains 381 inches, and $\frac{18}{21}$ of an inch; which fraction abbreviated makes $\frac{6}{7}$ part of an inch: So that the inſide or hollow part of the Granado contains 381 $\frac{6}{7}$ inches, which ſubſtracted from the inches found before in the ſolid Bullet, which was 1437 $\frac{1}{3}$

381 $\frac{6}{7}$
1056

there

there remains 1056 inches, which multiply by 4, because every Cube inch of Cast Iron weigheth four ounces, and the product is 4224 ounces; and so many ounces weight of metal is in the Granado Shell, and being that 16 ounces makes one pound, therefore divide the number of ounces by 16, and the Quotient gives you the weight of the metal in pounds.

1056
4
4224



Here I find in the Quotient 264 pound weight of metal in the Granado Shell: Therefore I answer to this Question, the Granado Shell contained 1056 inches, and weighed 264 pound weight. In the substraction I have omitted the fraction $\frac{5}{7}$, which being taken from the former summ, there rests 1055 inches, and $\frac{2}{7}$ parts of an inch, the just Cube inches of metal in the Granado Shell.

How

How by the Table, to find the Cube of any whole number and broken; that is, of any number that hath a fraction joyned to it.

LET the number be 28 $\frac{3}{4}$, and you desire to know the Cube of it, look in the Table for the Root 28, and to the left hand of it, you have the Cubick number of it 21952, and to the right hand of it you have the Denominator to it 2437; and because your fraction was $\frac{3}{4}$, therefore you must take the three fourths of the Denominator, and add it to the Cube of the whole number; and so you have the Cube of the whole and broken of 28 $\frac{3}{4}$.

Thus in the Cube Table you will find the denominator to the Root 28, to be 2437, and because your fraction was $\frac{3}{4}$, therefore multiply the denominator found in the Table 2437 by the numerator of the fraction 3, and divide the product by the denominator of the fraction 4; and you will find in the Quotient 1827 $\frac{3}{4}$, which is the Cube of the fraction desired, which

which being added to the firſt ſumm, to the Cube of 28, which was 21952, it makes 23779 $\frac{3}{4}$.

21952
1827
23779

2437
3
7311

3 3 3 (3
7 7 1 1
* * * *

(1827 $\frac{3}{4}$

21952
1827 $\frac{3}{4}$
23779 $\frac{3}{4}$

Thus by the Table I readily and with eaſe, find the Cube number of 28 and $\frac{3}{4}$, to be 23779 $\frac{3}{4}$. Here you may perceive and ſee, how uſeful this exact knowledge of the true value of the remainer is.

Another Queſtion. I deſire to know the Cubick number of 64 $\frac{2}{7}$; in the Cube Table I find the root 64, and with it to the Left Hand the Cube of it 262144, and to the Right Hand of it the denominator 12481, which denominator found in the Table, I multiply by the numerator of the fraction 2, and divide the product by the denominator of the fraction 7, and the Quotient is 3566, which

which is the Cube of the fraction desired, which being added to the Cube of the first summ, to the Cube of 64, which was 262144, it amounts to 265710, which is the Cubick number of $64\frac{2}{7}$, as here by practice is found.

12481
2
24962

3##
24962 (3566
7777

262144
3566

265710 —— $64\frac{2}{7}$
The Cube The Root

Another Question, what is the Cube number of $50\frac{8}{12}$? You may abbreviate the fraction eight twelfths, and it makes $\frac{2}{3}$, then in the Cubick Table find the root 50, and with it to the Left Hand is the Cube of it 125000, and to the Right Hand of it is the denominator to it 7651, which multiply by the numerator of the fraction 2, and divide the product by the denominator of the fraction 3, and the

Quotient is 5100 $\frac{2}{3}$ for the Cube of the fraction desired, which being added to the Cube of the first summ to the Cube of 50 which was 125000, the total is 130100 $\frac{2}{3}$, which is the Cubick number of 50 $\frac{2}{3}$, as here is found.

7651	(2
2	15302 (5100 $\frac{2}{3}$
15302	3333

125000
5100 $\frac{2}{3}$

130100 $\frac{2}{3}$ ——— 50 $\frac{2}{3}$

The Cube Number The Root

A Queſtion of a Bullet by the Cube Table.

AN Iron Shot whoſe diameter is 4 inches, doth weigh 9 pound, what ſhall the diameter of another Shot be which weigheth 72 pound?

As nine the weight of one Shot, to 72 the weight of the other Shot; ſo is the Cube of one Shots diameter to the Cube of the other Shots diameter; and the Table ſhews you the Cube of the firſt diameter 4 to be 64; then by the Rule of Three, I find the other Cube number to be 512, and in the Cube Table I find the Cube Root of 512 to be 8 inches, for the diameter of the other Shot whoſe weight is 72 pound.

This Queſtion above was put to me thus: If a Bullet 4 inches in diameter do weigh 9 pound, what ſhall the diameter of the Bullet be that weigheth 72 pound? Now I find that this Queſtion was put falſe, and therefore the anſwer agreeing thereto cannot be right; for a Bullet 4

inches in diameter, doth weigh but 8 pounds and $\frac{6}{16}$ parts, that is, 8 pound 6 ounces; as here is found by practice, thus:

An Iron Shot or Bullet 4 inches in diameter, how many Square Cubical inches is in the ſolid content? and what is the weight of it? In the Table you may find the Cube of 4 to be 64, which multiply by eleven, and the product is 704, which divide by 21, and the Quotient is 33 $\frac{11}{21}$ inches; and being that one inch of Caſt Iron doth weigh 4 ounces, therefore multiply the Quotient 33 $\frac{11}{21}$ by four, and the product is the Bullets weight in ounces, which divide by 16, and the Quotient is ſo many pounds as the Bullet doth weigh; and I find that the Bullet contained 33 $\frac{11}{21}$ inches, and weighed 8 $\frac{6}{16}$ pounds: Now the inches being 33 $\frac{11}{21}$ to multiply it by 4, and to ſave the trouble of working by broken numbers; conſidering that ſome underſtand not broken numbers, (for as I do here, ſo in other parts of this Book, I have laboured to ſhorten the work, both for eaſe and delight, to them that practice herein.)

There-

Therefore multiply 33 by 4, and the product is 132, and for the fraction $\frac{11}{11}$, it is very little more than one half; therefore add to the product one half of the multiplyer 4 that is 2, and it makes 134, which divide by 16, and the Quotient is $8\frac{6}{16}$, that is, 8 pound and 6 ounces, for the weight of the Bullet whose diameter is 4 inches.

Thus having found that a Bullet 4 inches in diameter, weigheth but 8 pound 6 ounces; I would know what is the diameter of the Bullet that weigheth 72 pounds?

Observe that one Square Cubical inch of Cast Iron doth weigh 4 ounces, what is the diameter of the Bullet that weigheth 72 pound? Multiply 72 by 16, and you have 1152 ounces, which divide by 4, and you have in the Quotient 288 Cubical Square inches, in the solid content of the Bullet; which multiply by

72	
16	
432	
72	
1152	ounces

21, and the product is 6048, which divide by eleven, and the Quotient is 549 $\frac{9}{11}$, which is the Cubick number of the diameter, and in the Table you may find the root of it to be 8 $\frac{37}{217}$ inch, the just diameter of the Bullet; this diameter is readily found by the Table.

	288
	21
	288
	576
	6048

11 (9
99
6048 (549 $\frac{9}{11}$
3333
22

And here observe, that 8 is the just root of the right Cube number 512; but this number found in the Quotient is 549, which is not a right Cube number; now also 8, is the root of this number 549, with some remainer: Therefore to find the remainer, substract the right Cube number 512, from this number 549, and there remains 37, and in the Table you may find the denominator to be 217, therefore I set it down thus:

	549
	512
	37

Num-

Number	Root	Remainer
$549\frac{9}{11}$	8	$\frac{37}{217}$

Now this remainer $\frac{37}{217}$ cannot be abbrevied; therefore to find the value of it, do thus: Multiply the numerator 37, by the leaſt figure you can, ſo that the product may be more than the denominator, and ſo may be divided by the denominator, as is here done; multiply 37 by 6, and the product is 222, which divide by the denominator 217, and the Quotient is one; and being that you multiplied by 6, therefore, that one in the Quotient, ſignifies one ſixth part of an inch, to be added to the diameter; and for to find this figure readily, which is to be the multiplier, do thus: Divide the Denominator 217, by its numerator 37, and you have 5 in the Quotient; and if nothing remain upon the diviſion, then that 5 muſt be the multiplier; but if any thing remain, then add one unite to the Quotient 5, make it

37	
6	
222	

1 (5	
222	(1 $\frac{5}{217}$
217	

6, now here remains 32, therefore 6 muſt be the multiplier.

And ſtill there remains a fraction upon this laſt diviſion, which is $\frac{5}{217}$, and for to find the value of this $\frac{5}{217}$, do as before; find the leaſt number you can for the multiplier, thus: Divide the denominator 217, by his numerator 5, and you have in the Quotient 43; and being that 2 remains, therefore according to my former directions, add one unite to the Quotient, make it 44, which is to be your multiplier; then multiply the numerator of the fraction 5 by 44, and the product is 220, which divide by the denominator of the fraction 217, and the Quotient is one, and $\frac{3}{217}$ ſtill remains; and being that you multiplied 44, therefore that one in the Quotient ſignifies $\frac{1}{44}$ of $\frac{1}{6}$ part of an inch, to be added to the Quotient, and yet there is a fraction more, that is $\frac{3}{217}$ of $\frac{1}{44}$ of $\frac{1}{6}$ part of an inch, which you may work if you pleaſe, as the other two fractions above are wrought; but being ſo very ſmall a part, they may be omitted,

2 (2 (.43
217
55

44
5
220

yet

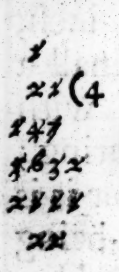
yet the firſt fraction $\frac{37}{217}$ may not be omitted, for it makes the diameter one ſixth part of an inch more, which is conſiderable in the weight of the Bullet, for it increaſes the weight of the Bullet 5 pound.

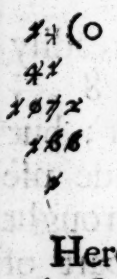
Alſo this $\frac{1}{8}$ part of an inch, may be made uſe of in meaſure, but the ſecond fraction which is but $\frac{1}{44}$ of $\frac{1}{8}$ part of an inch, being fractions of fractions, is ſo ſmall a part, that it cannot be made uſe of with the Compaſs and Scale in meaſuring; and the third fraction is ſtill leſs, for it is the broken of broken of broken, being the $\frac{3}{217}$ of $\frac{1}{44}$ of $\frac{1}{8}$ part of an inch, and being ſo very ſmall, cannot be made uſe of in meaſuring.

Now this Queſtion above, was readily and fully anſwered at the firſt, for 8 $\frac{37}{217}$ inches, is the juſt and true diameter; but becauſe the fraction cannot be made uſe of in meaſure; therefore I have wrought it as you ſee above, to one ſixth part of an inch: And alſo I have done it to ſhew you, how exact the Pen is in ſmall fractions, which cannot be diſcern'd upon meaſure.

A Bullet whose diameter is 8 inches, how many Square Cubical inches is in the solid content of it? And what is the weight? In the Table you may find in the Cubick number of 8, to be 512, which multiply by 11, and the product is 5632, which divide by 21, and in the Quotient you have 268, and so many square Cubical inches is in the solid content of the Bullet. And being that one inch of Cast Iron doth weigh 4 ounces, therefore multiply the Quotient by 4, and you have 1072 ounces, which divide by 16, and you have in the Quotient 67 pounds, which is the weight of the Bullet, whose diameter is eight inches.

512
11
512
512
5632





Here above, I find that this Bullet, whose diameter is 8 inches, wants 5 pound weight of the Bullet, whose diameter is 8 $\frac{1}{6}$ inches, that is, 8 inches, and one sixth part of an inch.

A Culverin, takes a Bullet 4 inches, and ¾ of an inch in diameter, how many Square Cubical inches is in the ſolid content of it? And what is the weight of the Bullet? And here in this Queſtion, you will find that the Table will readily anſwer a Queſtion of whole numbers and broken.

In the Table, you may find the Cubick number of 4, to be 64; alſo in the Table, in the ſame place, to the Right Hand of the Root 4, you may find the denominator to the remainer of the root 4, to be 61, and your fraction being ¾, therefore take the ¾ of 61, and add it to the firſt number 64, thus: Multiply 61, by the numerator of the fraction 3, and the product is 183, which divide by the denominator of the fraction 4, and the Quotient is 45 and ¾, which is the Cubick number of that fraction ¾, which belongs to the remainer of the root 4; which being added to the firſt number 64, makes 110.

	61
	3
	183

2 (3
183 (45 ¾
44

And

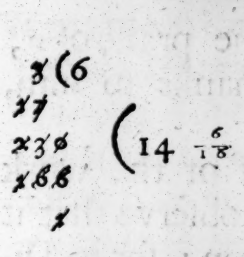
And by the way obſerve, that $\frac{3}{4}$ of a greater root than 4, is more than 61, becauſe it hath a greater denominator, as you may ſee in the Table; for every ſeveral root, hath a ſeveral denominator; And here in this Queſtion, you may ſee what excellent uſe, thoſe denominators in the Table are of: But to return to the Queſtion, having found the Cubick number of 4, and $\frac{3}{4}$ to be 110, multiply it by 11, and the product is 1210, which divide by 21, and the Quotient is, 57 $\frac{13}{21}$, and ſo many ſquare cubical inches is contained in the ſolid content of the Bullet: And being that one Inch of Caſt Iron doth weigh 4 ounces, therefore multiply the Quotient 57 by 4, and the product is 228; and for the fraction which remains upon the diviſion being $\frac{13}{21}$, it is very near $\frac{2}{3}$, therefore add the numerator 2 to the product, and it makes the product 230, which divide by 16, and the Quotient

110
11
110
110
1210

(1
xx
x6(3
xxxø
xxx
x
-

(57 $\frac{13}{21}$

57
4
228



tient is 14 $\frac{6}{27}$, that is 14 pound, and 6 ounces for the weight of the Bullet, whoſe diameter is four inches and three fourths of an inch.

Now, Loving Reader, who delighteſt to encourage Art and Ingenuity, I hope of your kind acceptance of this my labour, and that you will acknowledge this to be an eaſie, ready, and exact way to find the true Root of any Number, either Square or Cube, and thereby with great eaſe and delight, to work Triangles, Squares, or Circles, Gunnery, Gauging, Surveying, Military Diſcipline, and for the building of Ships; and that I have proved my work by a new way and true, which none before did ever find out; and ſome men are offended, becauſe the Author doth acknowledge he neither hath, nor pretends to Learning, farther than the Grammar, but only to the Arithmetick; therefore confeſſing himſelf to be ſo very weak in knowledge, he doth wholly aſcribe this work to the gift of God, whoſe power is made known in weak-

weakneſs; to God be all the praiſe of it, with humble and hearty thanks to him, by the Author.

Now to make the proof of the work more plain by Reduction, obſerve that it is not here as it is in Diviſion; for in Diviſion you have but one Diviſor, if the Quotient have three or four figures in it, and the Remainer of the Diviſion is always the Numerator to the Diviſor; but in extracting the Root of a number, the Remainer takes no notice of the Diviſor, but is a part of the number that adds one Unite to the Root of the next ſquare number; and if the Root of the number conſiſts of four figures, then in extracting the Root of that number, you have four ſeveral Diviſors, and four Multiplications; and to every ſeveral Multiplication you add the ſquare of the figure put laſt in the Quotient, and then you make your Subſtraction; and if nothing remain, then the number is a right ſquare number; and although in the work there be put to every Multiplication the ſquare of the figure put laſt in the Quotient, yet it is the true Root of the number: For Exam-

Example; Let 1483524 be a given number, the Root of it is 1218, as you may find it in the Table; and the next ſquare number to it is 1485961, the Root of it is 1219; now ſubſtract this leſſer ſquare number from the other, and there remains 2437: Now Subſtraction takes in one of the ſquare numbers, (for there are but 2436 numbers betwixt the two ſquare numbers,) and thoſe only are the ſurd numbers that have Remainers to the Root of them; and, as I have ſaid, there are 2436 ſurd numbers betwixt thoſe two ſquare numbers; now all thoſe 2436 numbers have one Root, which is common to them all, which Root is 1218; alſo they have all one Denominator, which is common to them all, which is 2437, it being the number, which being put to the leſſer ſquare, adds but one Unite to the Root of the next ſquare number. Alſo obſerve, that the ſquare of 8 being 64, is added to every one of thoſe 2436 ſurd numbers; and as one Root is common to them all, and one Denominator is common to them all; ſo alſo this addition of 64 is common to them all, without any encreaſing

creaſing it, until you come at the next ſquare number, and then the ſquare of 9 being 81, is added to all the ſurd numbers betwixt it and the next following ſquare number; therefore when you prove a Diviſion, by multiplying the Quotient by the Diviſor, you add the Remainer of the Diviſion to the product; ſo if you will prove a ſurd number, by Reduction, you muſt ſubſtract the ſquare of the numerator of the fraction from the greater multiplication; and although there have been 4 additions to this Root 1218, yet one Subſtraction produces the firſt given number; and that Subſtraction, if it be but the ſquare of one, which is ſtill but one, yet it anſwers all the four additions, and produces the firſt number. Again, if the numerator of the fraction be 2436, the ſquare of it being a great number, far exceeding the four additions, yet the ſquare of it being ſubſtracted from the greater multiplication, and divided by the product of the leſſer multiplication, it alſo produces the firſt given number. Example, of number 1483525, extract

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the Root of it, and you will find it to be 1218 $\frac{1}{2437}$. Alſo the number 1485960, extract the Root of it, and you will find it to be 1218 $\frac{2436}{2437}$, and thus of all other ſurd numbers.

Again, to prove a ſurd number by progreſſion, take thoſe two numbers above-named, that is, 1483524, and 1485961, being both ſquare numbers, and ſubſtract the one from the other, and there remains 2437; for the denominator to all the 2436 ſurd numbers, which are betwixt the two ſquare numbers and the Remainer of the Root of the ſurd number, is a part of that Denominator 2437, for it makes up the next ſquare number; for the root of 1483525 is 1218 $\frac{1}{2437}$, and thus the remainers encreaſe by progreſſion equally; for as the number encreaſes one unite, ſo the remainer encreaſes, until you come at the next ſquare number. Again, the root of 1485960 is 1218 $\frac{2436}{2437}$, which remainer wants but one part of one unite, being divided into 2437 parts. Again, let the root of 1485961 be 1218, and then the remainer will be 2437, the fra-

ction will ſtand thus $\frac{2437}{2437}$, which makes one whole, agreeing with the root.

You ſee here how equally by progreſſion the Remainers go on, encreaſing every one of them but $\frac{1}{2437}$ parts of one unite; all thoſe 2436 ſurd numbers, until you come at the laſt ſurd number; and although there be but that very ſmall part of one unite difference betwixt this laſt ſurd number and the next, yet the ſquare of nine is added to the next, and but the ſquare of eight to the other; and ſubſtract the ſquare of 8 from the ſquare of 9, and there remains 17, as you may ſee in the Margent; therefore being but $\frac{1}{2437}$ part of one unite difference in value betwixt them, and yet 17 whole added to the latter, therefore that reduction which proves the latter can never prove the former, being a ſurd number; yet I ſay, the former hath his juſt Root 1218, $\frac{2436}{2437}$, which comes very near one whole, to make up the next ſquare number. Alſo obſerve, that the ſquare of 8 being ſubſtracted from the ſquare of 9, the Remainer 17, is not added to the next ſquare number, nor to the Root of it,

it, for there is no ſuch difference betwixt them, there being but one unite difference betwixt the two ſquares, and but a very ſmall part of one unite betwixt the two Roots; but the 17 is added in the working of the queſtion equally by proportion, and produces the next ſquare number, and the Root; therefore all ſurd numbers are to be proved, as I have done above, and the Rule never fails.

The Author's Prayer and Thankſgiving to God.

GLorious Lord God, bleſſed be thy holy Name for ever and ever; bleſſed be thou for our Creation, Redemption, Sanctification, and for the hopes that thou haſt given us of being received into thy preſence, where there is fulneſs of Joy, and Eternal Joy; and bleſſed be thou for defending us againſt all our Enemies, both Spiritual and Temporal; for preſerving us, for ordering our buſineſs, and bleſſing our labours. Good Lord continue thy mercies unto me, and to all thine, and grant unto us thy holy Spirit,

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to guide us, that we may walk humbly before thee, giving thee all the Honour, all the Glory, and all the Praiſe, with a joyful Heart, and all for Chriſt Jeſus ſake; to whom with thee, and the Holy Spirit, be all Honour, Glory, Praiſe, and Thankſgiving, for ever; Amen.

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FINIS.

ERRATA.

PAge 41. line 15. r. *Cable*: p. 42. l. 21. r. 2220: p. 47. the product 3554: p. 50. r. 289: Root, p. 51. r. 37: p. 53. r. 74: Denominators, p. 117. r, 2175: Cube Table, Number, p. 162. r. 2460104: p. 173. r. 7414875: Denominators, p. 165. r. 19927: p. 171. r. 79219: Numerator, p. 180. r. 22816.